# OSTEOLOGY FOR STUDENTS

A. T. NORTON.

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Presented by

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# PREFACE.

OSTEOLOGY is the basis of Anatomy. Upon the skeleton, as upon a framework, the softer tissues are attached and superimposed; and, therefore, without a knowledge of the former it becomes impossible to comprehend the latter. Nevertheless it is a remarkable fact, that the student often delays for a considerable period the study of that portion of Anatomy which, when achieved, renders the whole comparatively easy. This is to be accounted for, because Osteology is difficult of comprehension, and often difficult of explanation, for it is rare to find a bone perfect in all its points; and, furthermore, it is a subject to be retained by memory alone, and not to be assisted by a matter of calculation, as though one character were due to or dependent upon another. To this may be added, that Osteology is a branch of knowledge entirely new to the student, totally distinct from the ordinary course of education, and the first of a difficult series which opens upon the pupil at the commencement of his Hospital career.

For the study of the Bones numerous works have been published from time to time, and latterly much simplified by the introduction of very copious and explanatory plates; but in the small volume now before the student, the author has endeavoured to omit all extraneous matter, and at the same time, by a brief yet pointed description, to free the subject of the inattractive character so frequently complained of by the young beginner. The Plates have been arranged in the form of an atlas, as by this means the reference to them is rendered easy, and the constant alteration of the pages or position of the book is avoided. It may be also observed that a vast amount of care has been bestowed upon these Plates by the artist, Mr. Sherard Coleman, under the constant superintendence of the author, in order to produce as closely as possible the effect of a well marked and solid bone, in place of the simple outline more generally adopted. The ossification of the skeleton is a branch so distinct from descriptive anatomy, that the author has preferred to place that portion of the subject in a separate chapter, giving the student the opportunity of making himself acquainted with the formation of the bones either individually or collectively.

In conclusion the author cannot refrain from remarking that he himself, when a student, learned osteology from that excellent and original work by Ward, and, in some few instances, has carried out the method of description adopted by him.

# OSTEOLOGY.

In describing the human skeleton, it matters but little what method is adopted, so long as every point and distinctive character are brought fully into notice. At the same time, it is advisable that anatomists should be guided by some few rules, in order to prevent the extreme confusion which might be otherwise produced.

In speaking of a surface or other characteristic point being external or internal, it must be understood to mean in reference to the median line of the body, and not to the median line of the part described.

With regard to osteological nomenclature, each author appears to make use of terms which strike him at the moment as being most applicable, so that comparatively few names occur but what, if not familiar, are at least comprehensible. In studying this work, the student is advised always to have the bone as well as the plate before him, and, in following the letter-press, to place the former in its exact position with regard to his own body, the correctness of which may be ascertained by reference to the latter. The use of the plates without the bones cannot be too strongly denounced.

The skeleton consists of a central trunk, the spinal column, supporting the skull at its upper extremity, and having connected with it anteriorly two spacious cavities, the thorax and pelvis, for the protection of the organs of functional life. Connected with the cavities are two pairs of limbs, the upper and lower extremities, or organs of prehension and progression. These several parts will be described in the following order :—

The Spinal Column.
The Thorax.
The Upper Extremity.
The Pelvis.
The Lower Extremity.
The Skull (Head and Face).

The skull, as being most complex, is given last, when the study of this part is rendered less difficult by the previous introduction to the subject; but it will be found better to follow the arrangement adopted in the course of lectures.

## THE SPINAL OR VERTEBRAL COLUMN. (*Plate* I.)

The vertebral column, exclusive of the sacrum, is made up of twenty-four segments or vertebræ, arranged one above the other, for the purpose of forming a support for the limbs, and an osseous protection to the spinal cord and main trunks of the blood-vessels. The segments receive the name of the several regions they occupy—Cervical, Dorsal and Lumbar—and present somewhat different characters, first with regard to each separate set, and secondly with regard to individuality, although all may be to a great extent comprised in one general description.

Every vertebra possesses a large mass or body, from which pass backwards two pedicles, each to support one transverse and two articular processes. From these are continued, in a direction backwards and approaching each other, two thin plates of bone, the laminæ, by the union of which posteriorly are produced a strong process, the spine, and an arch which, with the body, encloses a central aperture, the vertebral foramen.

The body is flattened upon its upper and lower surface, where, by the intervention of a fibro cartilage, it articulates with adjacent vertebræ, whilst its circular borders are prominent and attach in front the anterior common ligament. By this means the anterior surface of the body is rendered concave from above downwards, but is convex from side to side. The posterior surface of the body is, on the contrary, much flattened, or slightly concave from side to side, assists in forming the vertebral foramen, and is marked by large vascular foramina, for the supply of the cancellous mass.

The pedicles are simply narrow processes extending backwards, and, by their sudden diminution in size as compared with the bodies, produce above and below the vertebral notches which form with those of the vertebræ next in order the intervertebral foramina for the transmission of the spinal nerves.

The articular processes are four in number, a superior and inferior on each side. They articulate with the vertebra above and below, they look in different directions according to their region, and they possess a special capsular ligament.

The transverse processes project laterally, and give attachment to muscles and intertransverse ligaments.

The laminæ are thin plates, imbricating somewhat over the laminæ of the vertebra below. They support the spine posteriorly, and by their upper and lower borders attach the ligamenta subflava.

The spine projects posteriorly, and is the perceptible part of the column. It gives attachment to numerous muscles, and also to interspinous and supraspinous ligaments.

The vertebral foramen is the space contained within these bony structures.

## The Cervical Vertebræ (*Plate* I.)

are the first seven segments of the column, from the head downwards.

The body is small; longer from side to side than from before backwards; convex upon its under surface; and concave upon its upper, which, at each lateral extremity, presents a prominent ridge for the more perfect reception of the body of the vertebra above.

The pedicles differ greatly in this region in consequence of the peculiar attachment of the transverse process by two roots. They pass considerably outwards as well as backwards.

The transverse processes are attached by two roots, enclosing between them a circular foramen for the transmission of the vertebral artery. They run outwards and slightly downwards, and are bifurcated at the extremity.

The articular processes are much flattened, the two superior looking backwards and upwards, the two inferior forwards and downwards.

The laminæ are very long, thin and narrow from above downwards.

The spine projects somewhat downwards, and beneath its extremity becomes bifurcated.

The vertebral foramen is heart-shaped and very large.

Of the seven cervical vertebræ three may be recognized from the rest, the first, second and seventh.

The first cervical vertebra, called the atlas, possesses no body and but a rudimentary spine. It is composed of two lateral masses, from which the transverse processes proceed, and of an anterior and posterior arch. The anterior arch is a thin plate, convex in front, but excavated posteriorly for articulation with the odontoid process of the second vertebra.

The lateral masses are composed of the articular and transverse processes. The superior articular processes are long, concave, nearer to each other in front than behind, and look upwards, inwards and backwards. The inferior articular processes are circular and flat, are placed immediately beneath the superior processes, and look downwards and inwards.

The transverse processes arise from the outer surface of the lateral mass by two roots containing between them the foramen for the vertebral artery. They are truncated at the extremity, and there give origin to the superior oblique muscles and insertion to the inferior oblique. On the inner surface of each lateral mass, between the superior and inferior articular processes, is a rough depression, sometimes a tubercle, for the attachment of the transverse portion of the crucial ligament which assists in holding the odontoid process in position.

The posterior arch completes the bone. It projects posteriorly in the form of a tubercle for the origin of the two rectus capitis posticus minor muscles, and is smooth on its anterior surface where it bounds the spinal foramen. Upon its superior margin under cover of the superior articular process, is a groove continuous with the vertebral canal: it transmits the vertebral artery into the skull, and the first cervical nerve out of the skull.

The second cervical vertebra is termed the axis, since it is on this bone that rotation of the head takes place.

The body, on its anterior surface, presents a longitudinal line separating two rough depressions, into which are inserted the longus colli muscles: posteriorly it is flat and much perforated, and inferiorly assumes the characters common to the cervical vertebræ: superiorly the odontoid process, a club-shaped mass, ascends to take the place of the body of the atlas.

This process is smooth in front for articulation with the anterior arch of the atlas, and smooth behind from contact with the transverse ligament, but at its apex it is rough for the attachment of the odontoid or check ligaments.

On each side of the base of the odontoid process is the superior articular surface, which is flat, nearly circular in form, and directed upwards and outwards.

Beneath these the transverse processes project outwards and downwards, being pointed and not bifurcated; whilst more posteriorly are the inferior articular surfaces, comparatively small, flat and circular, and directed downwards, forwards and slightly outwards. The notches, the inferior of which are much the larger, lie in the line immediately between the superior and inferior articular processes. The laminæ are very strong, and terminate in a large but short spine, which is deeply grooved below, and which gives origin to the inferior oblique and rectus capitis posticus major muscles on each side of its extremity.

The seventh cervical vertebra approaches in character those of the dorsal region, presenting a spine of greater length, more inclined downwards, and tuberculated instead of bifurcated. The transverse processes also are not bifurcated, and are often deficient in the foramen for the vertebral artery.

## THE DORSAL VERTEBRÆ. (*Plate* I.)

The dorsal vertebræ, twelve in number, correspond in position to the cavity of the thorax, and in consequence of a posterior curve of the spine in that region, are rendered somewhat longer from above downwards on the posterior than on the anterior surface of their bodies. The body is much larger than that of a cervical vertebra, more prominent or convex from side to side on its anterior surface, and more concave on its posterior. It presents on each side two half facets, one at its upper and one at its lower border, for articulation each with one half of the head of a rib. The pedicles are well defined, forming the intervertebral notch in their lower part. The articular processes are flattened; and of these the superior are directed backwards and outwards, whilst the inferior, which have a tendency to concavity, take an opposite direction. The transverse processes are truncated externally; they pass obliquely outwards and backwards; and they present anteriorly a facet for articulation with the tubercle of the corresponding rib. The laminæ are broad, but do not extend far backwards. The spines are long, tuberculated at the extremity and imbricate the upper over the lower. The spinal foramen is nearly circular, and the smallest of the three regions.

Among the dorsal vertebræ, the first, ninth, tenth, eleventh, and twelfth, present sufficient differences to be distinguished from the rest and from each other.

The first has, instead of the ordinary two half facets on each side, an entire facet above and a demi-facet below. The spine also is very horizontal.

The ninth is deficient of its lower half facet, which is taken up by the tenth.

The tenth articulates with one entire rib, and therefore has one complete facet on each side. The eleventh and twelfth likewise possess one complete facet, but since they are connected with the two floating ribs there is no articular facet upon the transverse process. The inferior articular processes of the twelfth, exactly resemble those of a lumbar vertebra, being directed forwards and outwards.

## THE LUMBAR VERTEBRÆ. (*Plate* I.)

The lumbar vertebræ are five in number, and extend from the level of the ribs to the level of the pelvis.

The body is of large size and long in the transverse diameter: it is slightly longer from above downwards in front than behind, owing to the forward curve of the column. The pedicles are large, with the notch chiefly below. The transverse processes are long, but flat and thin, being longest in the third and shortest in the fifth and first. The articular processes are strong and massive, the superior being concave and directed inwards and slightly backwards; the inferior convex and in the opposite direction. The laminæ are thick, but short. The spine is heavy and horizontal, and enlarges at its extremity in a downward direction, but is not tuberculated. The spinal foramen is large and of a triangular form.

The fifth lumbar vertebra differs from the rest, in that the body is considerably longer from above downwards in front than behind; in that its transverse processes are short, pointed, and irregular for the attachment of sacro lumbar and ilio lumbar ligaments; and in that its inferior articular processes are widely separated for articulation with the sacrum.

## THE BONES CONSTITUTING THE THORAX.

### The Ribs. (*Plate* II.)

The ribs, twenty-four in number, twelve on each side, surround the cavity of the thorax, and correspond to the twelve dorsal vertebræ, with which they articulate posteriorly. The upper seven arc connected with the sternum in front, by means of costal cartilages, and receive the name of the true ribs: the remaining five are called false, and of these the two last, since they are free at their anterior extremities, are termed the *floating* ribs.

A *rib* is a long bone with two extremities, much curved and flattened laterally, so as to present an external and an internal surface, a superior and inferior border.

The posterior extremity or head of the rib articulates with two dorsal vertebræ by two facets, separated from each other by a horizontal ridge, which gives attachment to the interarticular ligament. Upon the anterior surface of the head the stellate ligament is attached. From the head the rib is directed outwards and backwards, and is at first somewhat constricted to form the neck. Here two ligaments are attached, the anterior costo-transverse to its upper border, the middle costo-transverse to its posterior surface. More externally the rib enlarges into a tubercle, part of which in the form of a facet articulates with the transverse process of the lower of the two vertebræ with which the head is connected, whilst the rest is rough for the attachment of the posterior costo-transverse ligament.

The remainder of the rib may be termed the shaft, and upon the outer surface of this, at a distance from the tubercle varying with the numerical position of the rib, an oblique line extends from its upper to its lower border forwards and downwards; and beyond this point the bone markedly curves forwards, producing what is termed the angle. Between the tubercle and the angle the erector spinæ muscles take attachment, and in front of the angle other muscles, differing according to the position of the rib. The inner surface is smooth, and along it, near the lower border, a groove courses from behind forwards.

The edges of this groove, one of which is the sharp inferior border of the rib, give attachment to the external and internal intercostal muscles. The superior border of the rib is rounded and attaches both layers of intercostal muscles. The anterior extremity is cup-shaped to receive its costal cartilage.

Of the twelve ribs the seventh is the longest, and from this they decrease, both above and below. When well marked the first, second, tenth, eleventh, and twelfth, are distinguishable from the rest.

The *first* rib is extremely short, and flattened so that its surfaces become superior and inferior, and its borders external and internal. The head is small and has but one facet, which articulates with the first dorsal vertebra; whilst the tuberosity is prominent, and the rib possesses no angle. The upper surface gives origin to the scalenus medius muscle by a depression running from the tuberosity forwards; and at its anterior third presents a more or less defined line, commencing internally by a tubercle and running forwards and outwards, for the origin of the scalenus anticus. Posterior to this line the subclavian artery is in contact with the rib, and anterior to it the subclavian vein. The subclavius muscle also arises from this surface at the junction of the rib with its cartilage. The inferior surface does not possess the usual groove; and the anterior extremity is very much thickened and generally incorporated with the sternum.

The second rib verges into the ordinary characters of a rib. Its surfaces are very oblique in position, one looking outwards and upwards, the other in the opposite direction: the former is strongly marked by the origin of the serratus magnus muscle, and behind this by the origin of the scalenus posticus muscle.

The tenth rib articulates with one vertebra only, and therefore possesses but one facet upon the head.

The eleventh and twelfth, or floating ribs, have each but one facet upon the head for articulation with one vertebra, and since they are not connected with the transverse processes, they possess no tuberosity: further than this, the angles are but very imperfectly if at all marked, and the grooves on the inner surface are absent.

## THE COSTAL CARTILAGES. (*Plate* II.)

The costal cartilages are prolongations of the ribs forwards, and serve to connect the upper seven with the sternum, as well as to give elasticity to the entire thorax.

The cartilage, at its costal extremity, fits into a cup-shaped depression in the extremity of the rib; the periosteum and the perichondrium becoming continuous at the sternal extremity. The cartilage of the first rib is united with the sternum: those of the second, third, fourth, fifth, sixth, and seventh articulate with depressions formed in the margins of the sternum, the joints being lined by a synovial membrane, and strengthened by anterior and posterior ligaments: those of the eighth, ninth, and tenth ascend to be lost each in the one next above: and those of the eleventh and twelfth are short, unattached, and floating.

The surfaces of the costal cartilages are anterior and posterior, the former being somewhat convex, and the latter somewhat concave for the thoracic cavity.

The borders, superior and inferior, are continuous with those of the ribs.

## THE STERNUM. (*Plate* III.)

The sternum is a flattened bone, occupying the median line of the anterior wall of the thorax. It is composed of five pieces, the lower four of which are always united together and tipped below by a process of cartilage. From the resemblance of the whole to a sword, the first piece, which is almost invariably separate from the rest, has received the name of the manubrium ; the four pieces united are called the gladiolus; and the apex the xyphoid or ensiform cartilage.

The *manubrium* is quadrilateral; broader above than below; convex upon its anterior surface, where it gives origin to the sterno mastoid muscles above, and to the aponeurosis of the pectoralis major muscle below; and concave upon its posterior surface, where the sterno hyoid and sterno thyoid muscles arise. The superior border is thick, and marked by two large concavo convex facets, for articulation with the clavicles. In front and behind these the anterior and posterior sterno clavicular ligaments are attached, and between them is a smooth portion, the interclavicular notch, for the reception of the trachea in extreme flexion of the head. The inferior border is in contact with the gladiolus, but is not usually attached, and at each extremity it articulates with a portion of the second costal cartilage by means of a half facet. The lateral borders are rough and irregular where the first rib is attached, and at their lower extremity exhibit the half facet for the second rib mentioned on the lower border.

The *gladiolus* is long, flat, wider below than above, and marked upon its anterior surface, which can be distinctly felt beneath the integument, by three transverse lines, the original separation of the bone into four. From this surface the aponeurosis of the two pectoralis major muscles arise. The posterior surface also shews the same transverse lines, and at the lower part gives origin to the triangularis sterni muscles. The lateral borders present a facet for articulation with the costal cartilage, situated at the extremity of each transverse line, but towards the lower part of the border the distance between the facets decreases, and often the sixth and seventh costal cartilage together articulate with that facet which is formed by the union of the xyphoid cartilage with the sternum. The upper border of the gladiolus is in contact with the manubrium, and is in old age sometimes connected with it by ossification. The lower is connected with the xyphoid cartilage.

The xyphoid or ensiform cartilage is an appendix of an irregularly triangular form, attached by its base to the sternum, and by its apex to the linea alba; and presenting laterally a half facet for articulation with the seventh costal cartilage. From its posterior surface fibres of the diaphragm and triangularis sterni muscles take origin. It is often perforate in its centre.

## THORAX. (*Plate* II.)

The dorsal vertebræ in the median line posteriorly, the sternum in the median line anteriorly, and the ribs and their cartilages laterally, together enclose a conical space, with the base downwards, termed the thorax.

The object of this osseous arrangement is for the protection of organs of vital importance, the heart and lungs, as well as to enable the action of respiration to be carried on by means of the alteration in position of the bones, and consequent increase and decrease of the contained cavity. The thorax possesses an aperture at the apex for the transmission of structures to and from the neck, bounded by the first rib on each side, the body of the first dorsal vertebra behind, and the superior margin of the sternum in front. It possesses also an aperture at the base of very much larger dimensions, which is bounded by the ensiform cartilage, the seventh, eighth, ninth, tenth, and the extremities of the eleventh and twelfth costal cartilages, the last rib, and the twelfth dorsal vertebra. This space is occupied by the diaphragm in the recent subject, and transmits numerous structures to and from the abdomen.

When viewed from without as a whole, the chest appears convex in every direction, although it is somewhat more flattened in front, where it is formed by the sternum and costal cartilages, than in other parts. Posteriorly, the spines of the dorsal vertebræ, overlapping each other, project as a prominent ridge, and on each side between the spines and the transverse processes is a considerable space occupied by the erector spinæ muscles, and described as the posterior vertebral groove. Laterally, the chest presents only the ribs running forwards and downwards, and separated from each other by intervals, the intercostal spaces. Viewed from within, the cavity appears flattened anteriorly, where it is bounded by the posterior surface of the sternum and costal cartilages; convex posteriorly in the median line where the bodies of the dorsal vertebræ project forwards, but on each side of these concave, where the ribs curve backwards to form what is frequently called the anterior vertebral groove; and lastly, markedly concave laterally where it is bounded by the concave surfaces of the shafts of the ribs.

## THE UPPER EXTREMITY.

### THE CLAVICLE. (*Plate* III.)

The clavicle is a much curved bone, horizontal in position, and articulated internally with the sternum, and externally with the acromion process of the scapula, for the purpose of retaining that bone and the upper limb extended from the body.

Near the sternum the bone is thick, solid, and angular, but as it approaches the scapula it becomes flattened and thin. The internal extremity articulates with the sternum by means of a large triangular facet, which is concave from before backwards, and convex from above downwards. It is directed inwards and downwards and projects downwards and backwards behind the corresponding facet of the sternum. The borders of this facet give attachment to the anterior, posterior, and superior or interclavicular ligaments respectively, and the joint is one of the few that possess an interarticular fibro cartilage. The external extremity articulates with the acromion process of the scapula by means of a small oval facet, directed forwards, downwards and outwards; and to its borders are attached superior and inferior acromio clavicular ligaments.

The shaft of the bone is curved forwards at the sternal half, where it cannot be said to possess surfaces distinguishable in all bones. This part may be distinctly felt beneath the integument, and gives origin to the sterno cleido mastoid muscle, by a marking about two inches in length along its superior aspect, and to the clavicular portion of the pectoralis major muscle by nearly a half of its anterior aspect; whilst the inferior aspect, which in size more nearly approaches to a border, presents a rough and strongly marked impression for the attachment of the costo clavicular ligament.

The acromial half of the shaft is flattened, and curves backwards so as to become concave upon its anterior margin. Its superior surface is somewhat rough, and covered by a tendinous communication between the trapezius and deltoid muscles. Its inferior surface presents a groove, in the depths of which is attached the subclavius muscle, and to whose borders is fixed the costo coracoid ligament. Within it also the nutrient foramen is usually to be found. More externally is a small tubercle, and from it a line is continued outwards, both for the attachment of the coraco clavicular or conoid and trapezoid ligaments.

The anterior margin is concave and rough for the origin of the deltoid muscle. The posterior margin is convex, and receives the insertion of the trapezius.

## THE SCAPULA. (*Plate* III.)

The scapula is a flat bone of triangular form, lying upon the posterior part of the thorax, and connecting the upper extremity to the trunk. It presents two surfaces, two processes, and three borders, the last of which by their union form three angles.

The anterior surface, or venter of the scapula, consists of a deep fossa for the origin of the subscapularis muscle, and is marked by horizontal lines, which attach tendinous intersections of the same muscle. At its posterior portion, more defined near the upper angle, is a flattened surface for the insertion of the serratus magnus muscle. The posterior surface or dorsum is chiefly convex, and is divided by a projection termed the spine into two unequal parts, the upper of which, one-third the size of the lower, bears the name of the supraspinous fossa, and gives origin to the supraspinous muscle, whilst the lower or infraspinous fossa gives origin to the infraspinous muscle. On this portion of the bone may be seen a line in close proximity to the outer border, separating a narrow surface which gradually widens as it descends towards the inferior angle, where it becomes divided into two parts, an upper and longer for the origin of the teres minor muscle, and a lower and broader for the origin of the teres major. The spine commences from the posterior border by a small triangular surface, from which it increases in size as it extends outwards, and finally terminates by flattening in a contrary direction, where it receives the name of acromion process. Its upper and lower surfaces assist in forming the supra and infra spinous fossæ respectively, and give origin to fibres of the muscles which arise within them. Its free posterior border or crest overlaps at its edges, above for the insertion of the trapezius, and below for the origin of the deltoid, whilst the intermediate portion is subcutaneous. Its external border is smooth, rounded, and free, and assists in forming a groove, known by the name of the neck, which transmits suprascapular vessels and nerves from the upper into the lower fossa. Its anterior or attached border is the part by which it arises from the posterior surface of the scapula.

The acromion process is a continuation of the crest of the spine outwards and forwards, its borders corresponding to the upper and lower lips, and its upper surface to the subcutaneous interval between them. It courses at first in the same direction as the spine, and then turns forwards and upwards to overlap the shoulder joint. By its anterior border, similar to the upper lip of the spine, it gives insertion to the trapezius, and articulates with the clavicle by means of an oval facet, which looks inwards and upwards; and by its posterior border, which, in turning, becomes external, it gives origin to the deltoid. Its upper surface is rough and subcutaneous, and its lower overlaps the joint, whilst the apex attaches the coraco acromial ligament.

The borders of the scapula are superior; external or axillary; and internal, vertebral, or base.

The superior border, the shortest of the three, presents externally a notch, which, when converted into a foramen by the suprascapular ligament, transmits the suprascapular nerve, whilst the ligament itself is crossed by the artery, and gives origin, together with a portion of the superior border, to the omo hyoid muscle. The external border is the strongest and stoutest of the three, and, by an impression below the head of the bone, an inch and a half in length, gives attachment to the tendinous origin of the long head of the triceps muscle: from this part it gradually lessens in width towards the inferior angle. The internal border runs nearly parallel with the vertebral column, and by that portion above the level of the spine of the scapula gives insertion to the levator anguli scapulæ. At the level of the spine, it gives origin to the rhomboideus minor, and between the spine and the inferior angle to the rhomboideus major; whilst into its anterior lip or margin in its whole extent, the serratus magnus is inserted and into the posterior some few fibres of the supra and infra spinous muscles. The superior angle is very thin, and separates the superior from the internal border. The inferior angle separates the internal from the external border, and to it properly belongs the triangular surface for the origin of the teres major muscle. Fibres of the latissimus dorsi are also often attached at this point. The external angle, situated at the junction of the superior and external border, is rightly termed the head of the scapula. It presents a large pear-shaped facet, with the apex upwards, described as the glenoid cavity, for articulation with the head of the humerus. This cavity is surrounded by the capsular ligament of the joint, to which it gives attachment, and is deepened by the glenoid ligament, a fibrous mass encircling the edges and becoming continuous at the apex of the cavity with the long head of the biceps muscle, which may therefore be said to take origin from it. Immediately behind the head is the contracted portion or neck already mentioned as being partly formed by the external border of the spine. Commencing from the head and superior border is the coracoid process, which, projecting at first upwards and slightly inwards, afterwards turns forwards and outwards to overlap the joint. Upon the upper surface is a roughened portion for the attachment of the coraco clavicular ligaments; by its anterior border it gives insertion to the pectoralis minor muscle; at its posterior border is attached the coraco acromial ligament; and from the apex two muscles, the coraco brachialis and short head of the biceps, arise together.

## THE HUMERUS. (*Plate* IV.)

The humerus is the longest and largest bone of the arm, and consists of a shaft with an upper and lower extremity.

The *upper extremity* articulates with the glenoid cavity of the scapula by a rounded head, the articulating surface of which is directed inwards, upwards, and backwards, and is encircled by a roughened groove described as the anatomical neck, and marking the extent of the articular cartilage. External and inferior to the anatomical neck, the upper extremity presents two tuberosities, the external and the internal, according to their position, separated from each other by a deep longitudinal groove.

The internal tuberosity is the smaller of the two, but is more defined, and receives the insertion of the subscapularis muscle. The external occupies the whole of the outer part of the extremity, and receives the insertion of three muscles, namely, from before backwards, the supraspinous, infraspinous and teres minor; whilst the separating groove conveys the tendon of the long head of the biceps muscle downwards from the joint, and a small articular artery upwards to the joint.

The shaft of the bone is somewhat contracted a little below the tuberosities, and from the liability to fracture at this point, it has been called the surgical neck. At the lower half the shaft becomes markedly triangular, but throughout it may be said to be divided by three lines or borders into as many surfaces.

The anterior border forms above the outer ridge of the bicipital groove, where it receives the insertion of the pectoralis major muscle; below this it occupies the median line of the bone, being under cover of the brachialis anticus muscle; and it terminates by dividing into two diverging portions which contain between them a depression, the coronoid fossa, for the reception of the coronoid process of the ulna in extreme flexion.

The internal border forms above the inner ridge of the bicipital groove where it receives the insertion of the teres major and latissimus dorsi muscles, and terminates below in the prominence of the internal condyle, above which for a short distance it is called the internal condyloid ridge.

The external border extends from the posterior part of the great tuberosity downwards to the prominence of the external condyle. In its whole extent fibres of the triceps muscle arise from it posteriorly; whilst from the lower fourth, which is strongly marked, and termed the external condyloid ridge, arise two muscles, the supinator radii longus, from about two inches, and below it the extensor carpi radialis longior.

The internal surface is the space between the anterior and internal borders, forming in its upper fourth the bicipital groove. Below this it widens considerably and presents a more or less roughened portion for the insertion of the coraco brachialis, whilst the rest of its extent gives origin to the brachialis anticus muscle.

The external surface lies between the anterior and external borders. It presents a well-defined rough impression in its middle third for the insertion of the deltoid muscle, and below this, though comparatively smooth, gives origin to the brachialis anticus.

The posterior surface lies between the external and the internal borders. It is covered by the triceps muscle, the external head of which arises as high up as the insertion of the teres minor on the great tuberosity, and the internal head as high as the insertion of the teres major. On the internal border, crossing from within outwards and very obliquely downwards, is a more or less marked groove formed by the musculo spiral nerve.

The inferior extremity of the humerus projects laterally in the form of two prominences, the condyles. Of these the internal is considerably the larger, and gives origin by a common tendon to the pronator radii teres, flexor carpi radialis, palmaris longus, flexor sublimis digitorum, and flexor carpi ulnaris muscles, as well as to the internal lateral ligament of the elbow-joint. The external condyle is smaller and more flattened, and gives origin to the extensor carpi radialis brevior, extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris and anconeus muscles, and to the external lateral ligament of the elbow-joint. This extremity terminates in an irregular articular surface, for articulation with the radius and ulna, the innermost part descending some distance below the rest, so that the arm in flexion is thrown across the chest. The external portion of this surface is globular, for articulation with the concavity upon the head of the radius, and is termed the capitellum; the remainder is called the trochlea, and articulates with the greater sigmoid cavity of the ulna.

In front of the lower extremity, immediately above the trochlea, is a triangular depression termed the coronoid fossa, for the reception of the coronoid process of the ulna in flexion; and external to it above the capitellum a small fossa, into which the head of the radius passes when the forearm is flexed to the extreme. Behind the lower extremity a very considerable cavity of triangular form, the olecranon fossa, receives the olecranon process of the ulna in extension, and so limits that motion. Above the fossæ which receive the processes of the ulna rise respectively the anterior and posterior ligaments of the elbow-joint.

## The Radius. (*Plate* IV.)

The radius is the external of the two bones of the forearm. It presents at its upper extremity a circular enlargement or head. This portion is concave above for articulation with the capitellum of the humerus, smooth in its circumference for motion within the orbicular ligament, and prolonged downwards internally for adaptation to the lesser sigmoid cavity of the ulna.

The head is supported by a smooth and circular constriction or neck, and is by it separated from a protuberance on the inner side of the bone, which, under the name of the tuberosity of the radius, receives on its inferior and posterior portion the insertion of the tendon of the biceps muscle.

The shaft of the bone is somewhat curved outwards, and presents on the side contiguous to the ulna a sharp internal border, along which is attached the interosseous membrane. This border extends from the tuberosity above downwards to the lower fifth of the bone, where, bifurcating, it encloses the sigmoid cavity or articular facet for the reception of the lower extremity of the ulna.

The shaft possesses also two other borders, an anterior and a posterior.

The former extends from the tuberosity downwards, and at first obliquely outwards, to the anterior edge of the styloid process. By its upper portion, termed the oblique line of the radius, it receives the insertion of the supinator radii brevis muscle, and gives origin to the flexor sublimis digitorum, whilst into its lower fourth is inserted the pronator quadratus.

The posterior border is the most indefinite of the three, and may be said to extend from the neck above to the posterior edge of the styloid process below.

Of the surfaces of the shaft, three in number, the anterior lies between the internal and anterior borders. It is slightly hollowed in its upper two-thirds, where the flexor longus pollicis arises, and is flattened in its lower fourth, where the pronator quadratus is inserted. The nutrient artery enters about the uppermost part of this surface.

The posterior surface lies between the internal and posterior borders. It presents above a smooth portion extending round towards the oblique line for the insertion of the supinator radii brevis, and below this a rough flattened portion, extending slightly below the centre of the shaft, for the origin of the extensor ossis metacarpi pollicis and extensor primi internodii pollicis.

The external surface lies between the anterior and posterior borders; and it presents about its centre a rough impression for the insertion of the pronator radii teres, and above this a smooth surface of considerable extent for the insertion of the supinator radii brevis. The lower part is smooth for the passage of tendons.

*The inferior extremity* of the radius presents a terminal articular surface of triangular form, whose apex is directed outwards, and which is divided by an antero posterior ridge into two parts, an external triangular for articulation with the scaphoid bone, an internal quadrilateral for articulation with the semilunar bone.

The internal aspect of the extremity exhibits the sigmoid cavity or facet for articulation with the lower extremity of the ulna already mentioned as contained in the bifurcation of the internal border of the radius.

The external aspect is formed partly by a process termed the styloid process, projecting almost perpendicularly downwards, into the base of which the supinator radii longus is inserted, and into whose apex the external lateral ligament of the wrist-joint is attached. The process is traversed by a perpendicular groove for the transmission of the tendons of the extensor ossis metacarpi pollicis and extensor primi internodii pollicis muscles.

The anterior aspect is simply a continuation of the anterior surface of the shaft and receives the insertion of the pronator quadratus : along its lower margin is attached the anterior ligament of the wrist-joint.

The posterior aspect presents a central tubercle, around the inner side of which curves a small groove for the tendon of the extensor secundi internodii pollicis. Internal to this groove is a second, for the tendons of the extensor communis digitorum and extensor indicis ; and external to it a third, for the tendons of the extensor carpi radialis longior and extensor carpi radialis brevior. The lower margin of this aspect gives attachment to the posterior ligament of the wrist-joint.

## THE ULNA. (*Plate* IV.)

The ulna is the companion of the radius, and the inner bone of the fore-arm.

Its upper extremity may be said to consist of two processes, a posterior, or *olecranon*, and an anterior, or *coronoid*, together forming a deep excavation under the name of the greater sigmoid cavity, for articulation with the trochlear surface of the humerus.

The olecranon process is the extreme portion of the bone, the subcutaneous prominence of the elbow-joint, and the limit to extension of the fore-arm. By its superior surface, which is quadrilateral, it gives insertion to the triceps muscle; by its anterior surface it enters into the formation of the greater sigmoid cavity; and by the borders of the same it gives attachment to the posterior ligament of the elbow-joint. The posterior surface is the part felt beneath the integument. The coronoid process projects forwards and presents a superior surface, which forms the inferior portion of the greater sigmoid cavity; an anterior surface, which gives insertion to the brachialis anticus muscle, and which possesses at the lower part a tubercle for the attachment of the oblique ligament of the elbow-joint; an internal surface, somewhat hollowed, and giving origin to slips of the pronator radii teres and flexor sublimis digitorum muscles; and lastly, an external surface, upon which is situated an oval articular facet, termed the lesser sigmoid cavity, and concave from before backwards for the rotating head of the radius. The flexor longus pollicis frequently takes origin by a fine slip of tendon from the coronoid process. The great sigmoid cavity is the space formed by the two processes. It is concave from above downwards, but in its depths presents a central longitudinal elevation for perfect adaptation to the trochlear surface of the humerus.

The shaft of the bone decreases in size from above downwards, and presents contiguous to the radius a prominent sharp external border, commencing above at the lesser sigmoid cavity, terminating below at the lower extremity of the ulna, and giving attachment in the greater part of its length to the interosseous membrane.

In front of the shaft the *anterior border* extends from the coronoid process above to the lower extremity of the ulna below. Its chief part is covered by the flexor profundus digitorum muscle, but in the lower fourth it gives origin to the pronator quadratus. Posteriorly an indistinct posterior border extends from the olecranon to the styloid process, and gives attachment to an aponeurosis common to the flexor profundus digitorum, flexor carpi ulnaris and extensor carpi ulnaris muscles.

Of the surfaces of the shaft, the anterior lies between the anterior and external borders. It is somewhat hollowed, it presents the medullary foramen, and it gives origin by its upper three-fourths to the flexor profundus digitorum, and by its lower fourth to the pronator quadratus. The internal surface lies between the anterior and posterior borders, and gives origin by its upper three-fourths to the flexor profundus digitorum, whilst it is, in the rest of its extent, subcutaneous.

The posterior surface lies between the posterior and external borders, and it presents in the upper fourth a ridge running from the lesser sigmoid cavity downwards and inwards, thus cutting off a small fossa below the lesser cavity, from which the supinator radii brevis muscle takes origin. On that portion of the surface above the ridge the anconeus is inserted, and from that below it arise in order from above downwards the extensor ossis metacarpi pollicis, extensor primi internodii pollicis (this latter frequently does not arise from the ulna), extensor secundi internodii pollicis and extensor indicis.

The lower extremity of the ulna is very small when compared with the upper. It possesses an inferior surface, separated from the carpus by the intervention of an interarticular fibro cartilage; a smooth circumference, a large portion of which is covered with cartilage, and articulates with the sigmoid cavity of the radius; and at its inner and posterior part an elongated tubercle of bone, the styloid process, which by its apex gives attachment to the internal lateral ligament of the wrist-joint and by its outer side to the interarticular fibro cartilage. On the posterior aspect of the lower extremity is a longitudinal groove for the transmission of the tendon of the extensor carpi ulnaris muscle.

## THE CARPUS. (*Plates* V. *and* VI.)

The carpus is composed of eight bones, arranged in two rows. In the first row, from without inwards, are the

Scaphoid, Semilunar, Cuneiform, and Pisiform bones; and in the second row, in the same order, the Trapezium, Trapezoid, Magnum, and Unciform. These bones are peculiar in possessing numerous articulating surfaces, and in yet always leaving an anterior or palmar, and a posterior or dorsal surface free for the attachment of ligaments. The dorsum of the hand is evidently more or less convex; while on the contrary the palm is to the same extent concave; and from this circumstance the dorsal ligamentous surfaces of the carpal bones are (with one exception) larger than the palmar. The semilunar bone differs from the rule in presenting its palmar larger than its dorsal surface.

### The Scaphoid Bone.

The scaphoid bone may be described as presenting two surfaces; one convex, in position, posterior and external, the other concave, in position, anterior and internal. It is the outer bone of the first row, and is placed with its long diameter extending downwards and outwards, its larger extremity upwards, and its convex surface behind. The *convex surface* is divided into two parts by a groove, thus producing a portion above irregularly triangular for articulation with the carpal surface of the inferior extremity of the radius, and a portion below for articulation chiefly with the trapezium, but from which a small part more internal and farther from the groove is marked off for articulation with the trapezoid. The groove itself, which may receive the name of the posterior ligamentous surface, runs horizontally from before backwards, and gives attachment to ligamentous fibres.

The *concave surface* presents a large excavation nearer its lower than its upper border, and of rounded form, to receive the head of the os magnum. Above this is a smooth flat semilunar facet for articulation with the semilunar bone; whilst below, and anterior to it, is a rough irregular surface, terminating anteriorly in a blunt tubercle, which corresponds to the anterior ligamentous surface, and which gives attachment to the anterior annular ligament of the wrist-joint.

## THE SEMILUNAR BONE.

The semilunar bone is the second of the first row. Somewhat of the form its name expresses, it presents six surfaces, and is, in all its characters, distinctly marked.

The anterior and posterior surfaces are rough for the attachment of palmar and dorsal ligaments; the posterior being usually much more rough and perforated than the anterior surface, which is exceptionally larger.

The external and internal surfaces are termed its semilunes, and of these the external is smooth and finely crescentic for articulation with its equivalent on the scaphoid; the internal is also smooth but more quadrilateral and articulates with the cuneiform bone.

·The superior surface is convex in every direction, smaller behind than in front, and smooth for articulation with the carpal surface of the inferior extremity of the radius.

The inferior surface is deeply concave, and smooth for articulation with the head of the os magnum; but a small portion at the innermost part of this surface is often separated off for articulation with the unciform bone.

## THE CUNEIFORM BONE.

The cuneiform bone, the third of the first row, is of conical form, situated with its base uppermost and with its long diameter extending downwards and inwards.

It distinctly possesses three surfaces, anterior, superior, and inferior; and a base. The anterior surface is somewhat depressed near the base where it is roughened for the attachment of the anterior ligament of the wrist-joint and for palmar ligaments, but near the apex it presents an oval convex facet which articulates with the pisiform bone.

The superior surface enters into the formation of the wrist-joint by a quadrilateral smooth facet near the base, which plays beneath the interarticular fibro cartilage attached to the lower extremity of the ulna; whilst the remainder or internal part approaching the apex is non-articular and roughened for the attachment of the internal lateral ligament of the wrist-joint.

The inferior surface is almost entirely articular. It possesses the largest facet on the bone, and this is of quadrilateral form extending downwards and inwards so as to overlap and articulate with the unciform bone.

The base looks almost directly outwards: it is articular, smooth, and of the same form as the internal surface of the semilunar bone, that is, approaching to a quadrilateral with the upper angles cut off.

## The Pisiform Bone.

The pisiform bone is small compared with the rest of the carpal series. It is of rounded form, well described as pea-shaped, and lies upon the cuneiform as though secondary to it. It possesses one large articular facet which occupies the whole of the posterior surface, and is oval and concave for articulation with a similar facet upon the anterior surface of the cuneiform bone, a synovial membrane, separate and special to itself, intervening. The bone is somewhat longer from side to side than from before backwards, and its external extremity is considerably the larger, projecting over the carpus so as partially to overlap the ulna vessels and nerves in their passage into the palm of the hand.

The superior surface receives the insertion of the flexor carpi ulnaris muscle, and is decidedly convex, whilst the inferior gives origin to the abductor minimi digiti, and has a tendency to overhang, thus producing a fine transverse groove which runs parallel with the border of the articular surface.

To recognize whether this bone belongs to the right or left hand is often very difficult, but when possible to determine the inferior surface it is much simplified, as the external extremity and the posterior articular facet are always tolerably distinct.

## THE TRAPEZIUM.

The trapezium is the first bone of the second row, commencing from without. The palmar and dorsal surfaces are as usual both rough for the attachment of ligaments, and of these the palmar surface presents upon it a deep longitudinal groove along which runs the tendon of the flexor carpi radialis muscle; whilst the prominent ridge situated upon the outer side of the groove gives origin to muscles of the ball of the thumb, namely, fibres of the abductor pollicis, opponens pollicis, and the outer head of the flexor brevis pollicis. The dorsal surface is larger than the palmar, and is rough and irregular for the attachment of the posterior carpal ligaments. The trapezium, when viewed from within, presents three articular facets, of which the middle is the largest: this is concave, somewhat quadrilateral and articulates with the trapezoid. 1 The superior is next in size, directed upwards and inwards, 2 more circular or semilunar in form and articulates with the scaphoid bone. The inferior is the smallest, directed 3 downwards and inwards, and articulates with the metacarpal bone of the index finger. When viewed from 4 without the trapezium presents two surfaces, an inferior which is larger, articular and of a saddle-shaped appearance for articulation with the metacarpal bone of the thumb; and a superior, which is nonarticular, separated from the lower by a prominent ridge, and rough and irregular for the attachment of the external lateral ligament of the wrist-joint.

## THE TRAPEZOID BONE.

The trapezoid bone is the second of the second row. It presents palmar and dorsal surfaces for the attachment of ligaments, but the rest of the bone is smooth for articulation.

The palmar surface is somewhat quadrilateral, and recedes at its external inferior angle. The dorsal surface is very much larger than the preceding, and is rough and irregular.

Around the bone may be distinguished four smooth surfaces for articulation. The largest of these, which may be called the inferior, is saddle-shaped, that is, convex from side to side, slightly concave in the long diameter: it looks directly downwards and articulates with the metacarpal bone of the index finger. The surface, which may be called the superior, is concave, looks directly upwards for articulation with the scaphoid, and is separated from the external surface only by a sharp border.

The external surface is flattened, and looks outwards and upwards to articulate with the trapezium.

The internal surface is long, narrow, and concave in its long diameter; and a large portion of it seems to be formed upon an inward projection of the bone near the dorsum. This surface articulates with the os magnum, and invariably presents about its centre a rough depression for an interosseous ligament between the two bones.

It is frequently difficult to distinguish the hand to which this bone belongs, but by attention to the above characters the internal, inferior, and palmar surfaces may be recognized and the bone determined.

## THE MAGNUM BONE.

The os magnum is the third bone of the second row, and the largest in the carpus. It possesses a rounded head, occupying a large portion of a sphere, attached to the body by a contracted portion or neck, and adapted to a socket-joint formed by the scaphoid and semilunar bones.

The articular surface of the head is plainly divisible into two parts, of which the upper is convex and quadrilateral, and articulates with the inferior surface of the semilunar bone. The lower or external extends downwards upon the outer surface of the body of the bone; it is also convex, but of more circular form; and it articulates with the scaphoid bone.

On the body of the bone the palmar surface is very prominent, except near the head, where it somewhat recedes; and it is usually marked by the nutrient foramen. The dorsal surface is broader, smoother, and somewhat excavated. The external surface is largely occupied by the downward extension of the scaphoid facet of the head, but at the lower part a facet may be distinguished for articulation with the trapezoid bone; and this facet is marked by a depression for the interosseous ligament, and is by it frequently divided into two parts.

The internal surface is almost entirely smooth, and articulates with the unciform bone. The inferior or metacarpal surface looks directly downwards towards the metacarpal bones, with three of which it frequently articulates. It is concave from before backwards, and articulates chiefly with the third metacarpal bone, but on each side a narrow slip is cut off; the outer and larger for the second metacarpal bone, the inner and smaller for the fourth.

## THE UNCIFORM BONE.

The unciform is the innermost bone of the second row, and receives its name from a hook-like process springing from its palmar surface.

The palmar and dorsal surfaces must be first sought for, and of these the palmar may be easily recognized by the unciform process which is attached to its inferior and internal part. This process is flattened laterally, but is somewhat concave upon its outer surface, where it bounds a space through which the flexor tendons pass; and its apex gives attachment to the anterior annular ligament of the wrist-joint and origin to the flexor brevis minimi digiti and opponens minimi digiti.

The dorsal surface is much larger than the palmar, and is rough for ligamentous attachment.

The inferior or metacarpal surface is divided by a ridge into two smooth facets for articulation, the inner with the fifth, and the outer with the fourth metacarpal bone.

The external surface articulates with the os magnum at the upper and posterior part, by means of a smooth articular facet, and at the lower part by the intervention of an interosseous ligament. The internal surface presents one large articular facet, peculiarly curved for articulation with the cuneiform bone, by which it is overlapped.

## The Metacarpus. (*Plate* VI.)

The metacarpus consists of five bones, which form the body of the hand, and receive their name either numerically, commencing from the thumb, or according to their respective digit; such as the metacarpal bone of the thumb, index, middle, ring, or little finger.

Each metacarpal bone presents a base or upper extremity, by which it articulates with the carpus; a head or inferior extremity by which it articulates with the phalanges; and an intermediate portion, or shaft.

The head is somewhat of rounded form, and owing to the greater amount of flexion than of extension of the fingers, continues its articular surface considerably more into the palm than on the dorsum.

On each side of the head is a depression, into which is attached the lateral ligament of the joint.

The shaft is concave in its length on the palmar aspect, where it presents a sharp border, and slightly convex on its dorsal aspect, where it presents somewhat of a surface. The interosseous muscles take origin from the lateral, and part of the dorsal surfaces of the shaft, and distinct markings may be observed for their attachments.

The bases differ in each instance, and by this means the several bones may be distinguished one from the other. Each base articulates laterally with its neighbours, except that of the thumb, which alone is free, and thus three bones may be at once partly determined; that of the thumb having no lateral facet at all, that of the index none on its radial side, that of the little finger none on its ulnar side.

The metacarpal bone of the thumb is much shorter but stouter than the others. On the palmar surface of its shaft the flexor ossis metacarpi pollicis takes insertion. Its carpal extremity articulates with the saddle-shaped surface of the trapezium, to correspond with which it is concave from before backwards, and convex from side to side. It has no lateral facets since it does not articulate with the other metacarpal bones; but on its outer side is a more or less developed tubercle for the insertion of the extensor ossis metacarpi pollicis.

The metacarpal bone of the index finger articulates with three of the carpal bones. The carpal extremity articulates chiefly by a large central facet with the trapezoid; a small portion passing outwards to the trapezium, and another inwards to the os magnum. When viewed from behind it seems to bifurcate and to enclose the trapezoid bone, but on the palmar surface the part which articulates with the os magnum extends into the carpus between that bone and the trapezoid, as a process of some size. Of the lateral surfaces, the inner presents two facets, or, sometimes one for articulation with the middle metacarpal bone; and the outer a tubercle for the insertion of the extensor carpi radialis longior. There is also a tubercle on the palmar surface for the insertion of the flexor carpi radialis.

The middle or third metacarpal bone may be at once recognized, and its hand determined by a stout process which extends up into the carpus from the posterior surface and outer or radial side of its carpal extremity, and which receives on its dorsal aspect the insertion of the extensor carpi radialis brevior. This extremity further articulates with the os magnum, and on each side with the next metacarpal bone.

The fourth metacarpal bone articulates with two bones of the carpus, the os magnum and unciform; and as the facet for the latter is much the larger, and necessarily more internal, the hand to which the bone belongs may be determined. On its inner side is one facet for articulation with the fifth metacarpal bone, on its outer two, or one for the third. The fifth metacarpal bone articulates with the unciform bone, but may be recognized by a tubercle on its internal lateral surface for the insertion of the extensor carpi ulnaris, and a facet on its external lateral surface for articulation with the fourth metacarpal bone.

## The Phalanges (*Plate* VI.)

are three in number for each finger, except the thumb, for which there are only two. They all resemble one another in being concave on the palmar surface, and convex on the dorsal; and in having a shaft and two enlarged extremities. A phalanx may be recognized as belonging to the first, second, or third row, but to which finger it is impossible to determine, unless all are present, and then only by its length. Two lateral and one palmar ligaments attach the metacarpal bone to the first phalanx, and the phalanges to each other, preventing the extension of the fingers beyond the level of the metacarpus. The phalanges of the first row are very long, compared with those of either the second or the third row, and are much enlarged at their metacarpal extremity. This extremity articulates with the rounded head of the metacarpal bone by a cup-shaped articular surface of very small dimensions, so as to allow a great amount of motion; and by a tubercle on each side it receives the insertion of the interosseous and lumbrical muscles, whilst that of the thumb receives on its outer tubercle the insertion of the abductor pollicis, and external head of the flexor brevis pollicis, on its inner tubercle the adductor pollicis and internal head of the flexor brevis pollicis, and on its dorsal surface the insertion of the extensor primi internodii pollicis. That of the little finger receives on its inner tubercle the insertion of the abductor minimi digiti and flexor brevis minimi digiti.

The shaft along the borders of its palmar surface presents well-defined ridges for the attachment of the sheath of the flexor tendons. The inferior extremity articulates with the middle phalanx by a surface which is concave from side to side, and convex from before backwards.

The phalanges of the second row are far inferior in size to the former, and their bases or larger extremities have on their articular surfaces an antero posterior ridge, rendering the entire facet convex from side to side, and slightly concave from before backwards. The shaft gives insertion by ridges on the borders of its palmar surface to the two slips of the flexor sublimis digitorum, and by its posterior surface to the central of the three slips of the extensor communis digitorum. The inferior extremity is similar to that of the first row. This bone is absent in the thumb. The phalanges of the third row (ungual) are small and peculiar: they articulate by their bases with the second row, and have the articular surface convex from side to side, concave from before backwards. The shaft receives the insertion of the flexor profundus digitorum on its palmar surface, and on its dorsal surface the two lateral slips of the extensor communis digitorum united. The terminal extremity is oval in form, flattened and rough on the palmar surface, but somewhat smooth on the dorsal.

## BONES CONSTITUTING THE PELVIS.

### The Sacrum. (*Plate* VII.)

The sacrum is an extension of the vertebral column downwards, and consists of five sacral vertebræ, which, uniting into a triangular or wedge-shaped mass, fit in between the ossa innominata, and so form the posterior wall of the pelvis. It is therefore described as one bone, which possesses an anterior, a posterior, and two lateral surfaces, with a base and an apex.

The anterior surface is, like the shape of the bone, triangular with the base upwards. It is slightly concave from side to side, markedly so from above downwards, and presents four transverse lines which mark the original separation of the sacral vertebræ; whilst at the extremities of these lines on both sides are the four sacral foramina through which the anterior sacral nerves leave the spinal canal. From the foramina grooves pass outwards upon the lateral masses of the bone, and from the ridges separating the grooves, as well as from the surface external to them, corresponding to about three sacral vertebræ, the fibres of the pyriformis muscle take origin.

The posterior surface is convex both from above downwards and from side to side, and upon it may be distinguished, though in an imperfect state of development, such parts of the vertebræ as would appear in a posterior view. Along the central line is a crest composed of the rudimentary spinous processes, the first being tolerably distinct, whilst the rest are united together. The fifth is usually altogether absent, and thus the spinal canal at this point becomes uncovered. On each side of the spines the laminæ and articular processes are blended together, though the latter often appear as a range of tubercles, and are well marked upon the fifth sacral vertebra where, in the form of a process or ridge on each side of the sacral canal, they are termed the cornua or horns of the sacrum, and unite with similar ascending processes, namely the cornua of the coccyx. Still further from the crest appear on each side the four posterior sacral foramina, through which four posterior sacral nerves are transmitted from the canal, whilst the fifth curves beneath the cornua of the sacrum. Lastly, the remainder of the surface corresponds to the transverse processes. It is very rough and tuberculated, and at the lower part gives origin to the glutæus maximus muscle and attachment to the sacro sciatic ligaments. The erector spinæ muscles take origin from the posterior surface of the sacrum on each side of the crest.

The lateral surface articulates with the ilium by means of an ear-shaped portion, described as the auricular surface, and behind and below this it presents a deep and rough depression for the attachment of sacro iliac ligaments. At the lower part the surface assumes rather the form of a border, and attaches the sacro sciatic ligaments.

The base of the sacrum much resembles a lumbar vertebra. It presents anteriorly the body thrown forwards so as to form a projection termed the promontory of the sacrum, and on each side of this a spreading surface, the ala. Posterior to the body are the articular processes, widely separated from each other, and in direction looking backwards and somewhat inwards; next appear the laminæ uniting posteriorly in the spinous process, and the whole enclosing the triangular aperture of the sacro spinal canal. The sacral canal is the continuation of the spinal canal, and contains the termination of the cauda equina. It is laid open at the lower part of the posterior surface of the sacrum, owing to the deficiency of the spine and laminæ of the fifth sacral vertebra.

The apex of the sacrum simply presents an oval facet for articulation with the first piece of the coccyx, and around it on each side the anterior fifth sacral nerve turns to the front.

## THE COCCYX. (*Plate* VII.)

The coccyx consists of three, four or five small bones united together, and frequently also united to the sacrum. Like the sacrum they curve forwards, decrease in size from above downwards, and are concave in front, and convex behind. The anterior and posterior surfaces present the marks of original separation, and attach, respectively, anterior and posterior sacro coccygeal ligaments. The first coccygeal bone is, when separate, much larger than the rest, and articulates with the apex of the sacrum: upon its posterior surface two processes, the cornua of the coccyx, ascend to meet the descending cornua of the sacrum.

The lateral borders of the united bones are irregular, and give origin to the coccygeus and the two great gluteal muscles and attachment to the sacro sciatic ligaments.

The apex of the coccyx frequently turns directly forwards, due probably to sitting, and it gives origin to the sphincter ani muscle.

## THE OS INNOMINATUM. (*Plate* VII.)

The os innominatum is made up of three bones, the ilium, the ischium and the pubes, all of which unite together in a deep cavity, situated upon the outer aspect of the bone, and termed the acetabulum.

Of the three bones the ilium is by far the largest, and extends upwards in the form of an expanding ala. The ischium, which is next in size, runs downwards, enlarges into the tuberosity for the attachment of strong muscles and to receive the weight of the body in the sitting posture, and then, becoming finer, turns upwards under the name of the ascending ramus of the ischium to meet the pubes.

The pubes, or the smallest of the three bones, extends from the acetabulum at first inwards and nearly horizontally towards its fellow of the opposite side under the name of the horizontal ramus of the pubes. Here it enlarges into a flattened portion and then again descends obliquely outwards, as the descending ramus of the pubes, to join with the ascending ramus of the ischium.

The os innominatum is usually described as one entire bone, presenting two surfaces and four borders.

The internal surface is divided into two parts by a horizontal marking, the ilio pectineal line or prominence of the brim of the true pelvis, the part below entering into the formation of the true pelvis, the part above into that of the false. In reference to the part above the line which belongs to the false pelvis, it is formed by the ilium only, and is directed inwards and forwards. It presents posteriorly a rough and irregular portion, part of which in the form of an ear articulates with the auricular surface of the sacrum, whilst the rest attaches the sacro iliac ligament. The anterior part of this division is concave in all directions, and gives origin to the iliacus muscle, whence termed the iliac fossa: and it is usually perforated by the nutrient foramen. The surface below the ilio pectineal line, or that which belongs to the true pelvis, is directed backwards and inwards, and is formed chiefly by the ischium and pubes. It presents a large aperture, the obturator foramen, which in life is occupied by a thin structure, the obturator membrane. This foramen is oval in the male, but in the female it becomes triangular, owing to the greater obliquity of the rami of the pubes and ischium, for the enlargement of the outlet of the pelvis; and it is deeply grooved at its upper margin for the passage of the obturator vessels and nerve. Fibres of the levator ani arise from this surface near the upper portion of the internal margin of the foramen, and a large muscle, the obturator internus, takes origin from the obturator membrane, the borders of the foramen and from the extensive surface posterior to the foramen.

The external surface presents centrally a deep circular cavity, the acetabulum, for articulation with the head of the femur. Its circumference is deficient in the anterior inferior part for the passage of vessels and nerves into the joint, and it gives attachment to a fibro cartilaginous structure termed the cotyloid ligament, which, extending across the notch under the name of the transverse ligament, serves to deepen the entire cavity. In the depths of the acetabulum is an irregular excavation, the sharp margin of which attaches the ligamentum teres, whilst the fossa itself is filled with fat vessels, &c. The acetabulum is formed by the union of the three bones, about one fourth by the pubes, and of the remainder, rather more by the ischium than by the ilium. It is surrounded by and gives attachment to the capsular ligament. The surface of bone above the acetabulum corresponds to the ala of the ilium, and is marked by three curved lines, of which the superior is the shortest, and cuts off a small rough portion for the origin of the glutæus maximus. The middle is the longest and most curved, commencing from near the anterior superior spinous process of the ilium and running to the posterior part of the great sciatic notch. The surface between these two curved lines gives origin to the glutæus medius. The inferior curved line is not so well defined as the other two, but may be traced from the anterior inferior spine to the great sciatic notch. Between it and the middle curved line the glutæus minimus arises, and between it and the acetabulum there is a rough marking for the origin of the external head of the rectus femoris.

The surface below, or internal to the acetabulum, presents the outer aspect of the obturator foramen, the border of which together with the obturator membrane gives origin to the obturator externus muscle, whose tendon is transmitted through a deep groove situated between the acetabulum and the tuberosity of the ischium. Anterior to the obturator foramen is the surface formed by the junction of the horizontal with the descending ramus of the pubes. From this part the adductor longus takes origin by a rounded tendon, and lower down, the adductor brevis, the latter having a much larger origin than the former. From the descending ramus of the pubes and the ascending ramus of the ischium, extending as far as the tuberosity, the adductor magnus arises.

*The borders of the os innominatum.*—The superior border is called also the crest of the ilium. It is convex and much curved, and terminates both in front and behind in prominences termed respectively the anterior and posterior superior spinous processes of the ilium.

It attaches three layers of muscles, and hence may be said to possess three lips, of which the external receives the insertion of the obliquus externus muscle in its anterior three-fourths, whilst of its anterior extremity about one inch and a half gives origin to the tensor fasciæ femoris, and of its posterior a fourth gives origin to the latissimus dorsi.

The middle lip gives origin to the obliquus internus by its anterior two-thirds, and behind this the erector spinæ takes origin.

The internal lip gives origin to the transversalis abdominis by its anterior two-thirds, and by the posterior fourth to the quadratus lumborum. At the anterior superior spinous process Poupart's ligament is attached, and the anterior border commences; and from the process as well as from about an inch of the anterior border the sartorius muscle arises. The anterior border commences from the anterior superior spinous process, and for the first inch gives origin to the sartorius. It next presents an elevation, the anterior inferior spinous process, from which arises the internal head of the rectus femoris muscle, and to which is attached also the ilio femoral ligament, a collection of fibres which strengthen the capsule of the hip-joint. Below the inferior spine the border becomes smooth, forms a groove for the passage of the tendons of the psoas and iliacus muscles in their exit from the false pelvis, and then again presents an elevation, the ilio pectineal eminence, into which is inserted when present the psoas parvus muscle. From this eminence the ilio pectineal line extends inwards to terminate in a little process, the spine of the pubes, the line and depression in front of which give origin to the pectineus muscle, whilst to rather more than an inch of the sharp margin adjoining the spine of the pubes Gimbernat's ligament is attached, and to the spine itself Poupart's ligament. From the spine of the pubes a rough margin, the crest of the pubes, is continued inwards to the termination of the border, about one inch in length. It gives insertion to the external oblique muscle and to the united tendon of the internal oblique and transversalis muscles, and origin to the pyramidalis and rectus abdominis. Descending from the inner point of the crest is an oval surface, rough for the attachment of a fibro cartilage, by means of which the two pubic bones articulate with each other, and here commences the inferior border. This border is extremely thin, and is formed by the pubes and ischium only. From its anterior margin for rather more than two inches the gracilis muscle takes origin; behind this the crus and erector penis in the male, clitoridis in the female; behind these again the elevator and compressor urethræ, and low down, near the tuberosity, from a small space, the transversus perinæi. Below this point the border suddenly enlarges into the tuberosity of the ischium, and here becomes separated from the posterior border.

The tuberosity gives origin by a large and distinct roughening at its upper broad part to the hamstring muscles, the semimembranous above and the long head of the biceps and semitendinous below. From the outer border the quadratus femoris and fibres of adductor magnus arise, and from the upper part of the inner border the gemellus superior. The inner border projects in the form of a sharp edge of bone which gives attachment to the great sacro sciatic ligament.

Continuing the circumference of the os innominatum the posterior border extends from the tuberosity of the ischium upwards to the posterior superior spinous process of the ilium, from which point the description of the borders was commenced. The posterior border presents immediately above the tuberosity a groove or depression, the lesser sciatic notch, and this by means of the great sacro sciatic ligament becomes converted into a foramen, through which the obturator internus passes outwards and the pudic vessels and nerves inwards to the perinæum. Separating the lesser sciatic notch from a very extensive space, the greater sciatic notch, is a triangular process, the spine of the ischium.

The spine gives origin by its external surface to the gemellus superior, by its internal surface to the levator ani and coccygeus; and receiving the attachment of the lesser sacro sciatic ligament at its apex, converts the great sciatic notch into a large foramen, through which the gluteal vessels and nerve, the pyriformis muscle, the sciatic vessels and nerves, and the pudic vessels and nerve leave the pelvis in order from above downwards. Above the great sciatic notch is the posterior inferior spinous process, and this is separated by a small notch only from the posterior superior spinous process of the ilium, from which the superior border has been seen to commence.

## THE PELVIS. (*Plate* II.)

The pelvis is the space enclosed by the sacrum and ossa innominata, but since the iliac portions of those bones ascend considerably above the sacrum, and one portion of the cavity is more capacious than the other, it has been divided into a *true* and a *false* pelvis.

The *false pelvis* is bounded laterally by the expanding alæ of the iliac bones, having behind the last lumbar vertebra, between which and the ala is the ilio lumbar ligament, and in front an open space limited only by the softer tissues of the abdominal walls. The cavity thus formed is much more extensive at its upper than at its lower portion, and is separated from the true pelvis by what is termed the brim of that space. The brim commences in front with the horizontal ramus of the pubis, and passes backwards through the ilio pectineal eminence and along the ilio pectineal line to the sacro iliac synchondrosis, where the promontory of the sacrum connects this border with that of the opposite side. The cavity contains a very large portion of the intestinal canal, as well as muscles, vessels, and nerves; and it has consequently been connected in the description of the abdominal cavity, and divided into three regions, a right and a left iliac, and a central or hypogastric. The inner surface of each ala is termed the iliac fossa; it gives origin to the internal iliac muscle; and is occupied on the right side by the cœcum and on the left by the sigmoid flexure of the colon. The central portion is occupied by convolutions of the small intestines, by the upper part of the bladder when that viscus is distended, and in the female during gestation by the gravid uterus.

The minutiæ of the external parts of the osseous boundary of the false pelvis, namely, the outer surface and the margins of the ala of the iliac bone, have previously been described.

The *true pelvis* is a cavity of smaller dimensions than the false pelvis, and is bounded by strong osseous walls, which are formed posteriorly by the sacrum and coccyx, laterally and in front by the ischial and pubic bones; it is therefore much deeper behind than in front. It is the space through which the child passes in parturition. It possesses a superior aperture or brim, and an inferior aperture or outlet, and, in consequence of the curve taken by the cavity, and of its irregular depth, it follows that these apertures occur in a plane, horizontal neither to each other nor to the body.

The superior aperture or brim of the true pelvis has already been mentioned as the line of separation between it and the false pelvis. It is slightly larger in the male from before backwards than from side to side; it is indented posteriorly by the promontory of the sacrum; and it is placed very obliquely with regard to the central line of the body, so that its axis would occur in a line drawn from the umbilicus to the tip of the coccyx. The inferior aperture of the osseous pelvis is extremely irregular, being indented laterally by the greater and lesser sciatic notches, and having the projection of the coccyx posteriorly; but it is rendered more regular in form and smaller in size by the greater and lesser sacro sciatic ligaments, which extend from the lateral margins of the coccyx and sacrum to the tuberosity and spine of the ischium. The plane of this aperture is such that its axis would be within the line drawn from the promontory of the sacrum through a point midway between the tuberosities of the ischia.

The cavity of the true pelvis curves in accordance with the sacrum, and is occupied by the bladder and rectum, by large vessels and nerves ; also in the male by the prostate gland, vesiculæ seminales, and vasa deferentia, and in the female by the vagina uterus and ovaries.

The female pelvis differs in many points from that of the male. It is less developed for strength and more delicately formed, but it is of larger dimensions, particularly in the transverse diameter. In the false pelvis the alæ are more shallow but extended in width, and in the true pelvis the brim is oval, with the long diameter from side to side. The pubic arch is larger, smoother on its posterior aspect, and is rounded at the symphysis pubis, not ascending to a sharp angle, as in the male.

The obturator foramen is more triangular, its inner portion being cut off by the great divergence of the sides of the pubic arch. Lastly, the sacrum is somewhat shorter, but broader and more curved, and the coccyx more movable ; whilst the whole cavity is not so deep as in the male.

## THE LOWER EXTREMITY.

### THE FEMUR. (*Plate* VIII.)

The femur is the only bone in the thigh. It articulates with the os innominatum by means of a rounded head projecting obliquely inwards, and upwards from the shaft of the bone, to which it is connected by the intervention of a contracted portion or neck. The head is in shape about two-thirds of a sphere, and is smooth for articulation with the acetabulum. The articular surface is surrounded by a line which marks the attachment or extent of the articular cartilage, but near its centre it presents a roughened depression in which is attached the ligamentum teres.

The neck supports the head upon its summit, and is attached to the shaft by its base. It is flattened from before backwards, extends upwards and inwards with an obliquity gradually decreasing as the subject advances in years, and it is marked throughout with numerous vascular foramina. At the junction of the neck with the shaft there is formed anteriorly a well-defined line for the attachment of the capsule of the hip-joint, but posteriorly this ligament is attached more closely to the head and not to so rough a line. There is, however, more externally an elevated ridge uniting together two large processes, the trochanters, and hence called the intertrochanteric ridge.

The trochanter major is a continuation of the shaft upwards, and may be said to be of quadrilateral form, having four borders and two surfaces. The anterior border presents a rough depression for the insertion of the glutæus minimus; the posterior forms the intertrochanteric ridge; the superior gives insertion to the pyriformis, gemellus superior, obturator internus, and gemellus inferior, the tendon of these muscles extending downwards upon the inner surface of the great trochanter towards the digital fossa; and the inferior border is simply a line separating the trochanter from the outer surface of the shaft, and marking the uppermost origin of the vastus externus. With regard to the surfaces, the internal exhibits a large depression, the digital fossa, which receives the inserting tendon of the obturator externus; and the external is divided by a line running from behind downwards and forwards into two portions, an upper or anterior, for the insertion of the glutæus medius, and a lower or posterior, which is covered by a synovial sac to permit the gliding motion of the tendon of the glutæus maximus.

The trochanter minor is a rounded prominence at the inner and posterior part of the upper extremity of the bone at the lower end of the intertrochanteric ridge. It gives insertion to the united tendon of the psoas magnus and iliacus muscles.

The shaft of the femur is cylindrical in form, curved forwards slightly in its length and inclining inwards towards the knees, so that it follows that the femur of a female would have a greater inclination inwards than that of a male, in consequence of the greater breadth of the female pelvis. The shaft presents on its posterior aspect a strongly marked longitudinal ridge, the linea aspera, and this communicates above with both trochanters, and below bifurcates into two lines, which, leading to the condyles, are termed the condyloid ridges. The linea aspera may be said to consist of three fine lines separated from each other by two intervals, as thus the mode of attachment of muscles becomes much simplified. The external of the three lines gives origin to the vastus externus, from the great trochanter to the upper third of the external condyloid ridge; the internal gives origin to the vastus internus, a muscle which also arises from the line leading to the lesser trochanter; and the middle, in its whole extent from the trochanter major to its termination, gives insertion to the adductor.magnus, whilst a continuation of this line upwards upon the posterior border of the trochanter major gives insertion to the quadratus femoris, and receives from some authors the name of the linea quadrata. Now, concerning the intervals between these lines, the external, which lies between the adductor magnus and vastus externus, is roughened by two muscles, the insertion of the glutæus maximus in its uppermost three inches and the origin of the short head of the biceps in its lower half. The internal interval, which lies between the adductor magnus and the vastus internus, gives insertion by its middle third to the adductor longus, and above and slightly external to this to the adductor brevis. From this point the line ascends to the lesser trochanter, and into it the pectineus is inserted.

The internal surface of the shaft gives origin to the vastus internus, the external surface to the vastus externus near the trochanter major, but not to any extent downwards. The anterior surface gives origin to the crureus in about its upper half or two-thirds, and nearer the lower part to a small muscle, the subcrureus.

The lower extremity of the femur increases suddenly to a large size when compared with the size of the shaft. It consists of two large articular masses termed condyles, separated from each other posteriorly by a considerable space, the intercondyloid notch, but continuous anteriorly.

The internal condyle is the larger, projects more laterally and extends lower, but the external is thrown more forward of the two. Each articulates with the tibia by an inferior convex surface, which is smooth for the articular cartilage, and this smoothness extends upwards upon the posterior surface for the same articulation in flexion of the leg, and also upwards upon the anterior surface for articulation with the patella. It must be noticed that the surface for articulation with the patella is continuous upon the two condyles, an antero posterior groove alone marking the separation, but that the portion upon the external condyle is much the larger, being broader and extending higher. By this means it will be afterwards seen the side to which the patella belongs may at once be recognized. The lateral prominence of the internal condyle gives attachment to the internal lateral ligament, and projects upwards and backwards in the form of a small tubercle, which, on looking to the back of the bone, is found to be the termination of the internal condyloid ridge, and gives insertion to the tendon of the adductor magnus muscle. The lateral prominence on the external condyle attaches the external lateral ligament, and immediately behind this may be seen a small fossa which gives origin to the popliteus muscle, and from which a groove extends backwards occupied by the tendon of the same muscle.

A posterior view of the entire lower extremity of the femur presents most distinctly the intercondyloid notch, in the sides of which, formed by the outer surface of the internal condyle and the inner surface of the external condyle, are rough depressions for the attachment of the posterior and anterior crucial ligament respectively. Altogether above the condyles is a triangular space between the two condyloid ridges, and within this space, upon the outer side, immediately above the articular surface of the external condyle, the plantaris and the outer head of the gastrocnemius take origin, the former often from a small fossa. Above the articular surface of the internal condyle arises the internal head of the gastrocnemius; and here again may be noticed the tubercle for the insertion of the adductor magnus.

## THE PATELLA.

The patella, or knee-cap, is a small triangular bone, frequently described as sesamoid, or contained within the tendon of the quadriceps extensor muscle. It is situated over the knee-joint, its base upwards, its posterior surface gliding upon and articulating with the condyles of the femur.

The anterior surface is subcutaneous, being covered only by a bursa and the integument; into it are inserted fibres of the quadriceps extensor, giving it an appearance longitudinally like the grain in wood.

The posterior surface is chiefly articular and presents two fossæ, separated from each other by an elevation, and exactly adapted to the anterior part of the articular surface of the lower extremity of the femur. As mentioned in the description of the femur, the external of the two depressions is the larger and deeper, to correspond with the external condyle, and thus the side to which the bone belongs may be determined. The lower part of the posterior surface is non-articular and overlaps the joint. The base of the bone is upwards, and gives insertion to fibres of the quadriceps extensor. The apex is directed downwards, and attaches the ligamentum patellæ.

The lateral borders are connected also with the tendon of the quadriceps extensor, and with this and the ligamentum patellæ the two lateral ligaments of the knee-joint are connected.

## THE TIBIA. (*Plate* VIII.)

The tibia is the internal and larger of the two bones constituting the leg.

The superior extremity, which alone articulates with the femur and receives the weight of the entire body, is very considerably larger than any other portion of the bone. Its superior surface, by which it articulates with the femur, presents two large and smooth depressions, separated from each other by an elevated process of bone, the spine of the tibia. The depressions articulate with the condyles of the femur, and are deepened by means of a semilune of interarticular fibro cartilage, situated upon their free margins; whilst the spine itself, which is bifid at the apex, ascends in the interval described as the intercondyloid space of the femur. The spine gives attachment to the anterior and posterior extremities of the external semilunar cartilage, but not to those of the internal, which do not so closely approach it; and from a rough depression immediately in front and behind the spine the anterior and posterior crucial ligaments take strong attachment. For the purpose of supporting the articular depressions the upper extremity of the tibia projects considerably on each side, and the prominences are termed the internal and external tuberosities.

The internal tuberosity, which is the larger of the two, gives attachment by the lateral portion of its circumference to the internal lateral ligaments, and into a rough depression at its posterior part the semimembranosus muscle is inserted. The external tuberosity presents on the posterior part of its circumference a small facet, the direction of which is outwards, downwards and backwards for articulation with the head of the fibula, and in contact with this, but above and internal to it, there is a smooth groove, along which the popliteus muscle runs to its insertion. The anterior aspect of the upper extremity of the tibia presents only a solid protuberance of bone termed the tubercle, which gives attachment to the ligamentum patellæ, or, as it may be described, the tendon of the quadriceps extensor; a bursa intervening between the tendon and the bone.

The shaft of the tibia is markedly triangular, having three distinct surfaces, separated by three borders. The anterior border extends from the tubercle downwards to the lower extremity. It is commonly called the shin-bone and is sharp and prominent in its upper three-fourths, but in the lower fourth it is smooth and curves inwards towards the malleolus, in consequence of the passage of the extensor tendons over this part of the bone. The internal border extends from the internal tuberosity to the posterior margin of the malleolus, and it is most developed in its central third, where fibres of the soleus muscle arise.

The external border commences from the articular facet for the fibula, and extending downwards, bifurcates below for the production of a groove in which the lower extremity of the fibula is fixed. To this border is attached the interosseus membrane between it and the fibula.

The internal surface is situated between the anterior and internal borders, and may be felt upon the inner side of the leg, subcutaneous in its whole extent and continuous with the inner surface of the malleolus. Upon its upper part, about the level of the tubercle of the tibia, three muscles, the sartorius, gracilis, and semitendinosus take insertion, uniting and sending processes of their tendon to strengthen the thick aponeurotic fascia of the leg.

The external surface is situated between the anterior and external borders. For the greater part of its extent it looks directly outwards, and gives origin to the tibialis anticus, but the lower fourth of the surface following the course of the anterior border curves over the front of the lower extremity of the tibia and becomes smooth for the passage of the extensor tendons.

The posterior surface occupies the space between the external and internal borders. In the upper third a distinct line may be observed running from the articular facet for the fibula downwards and inwards to the internal border, thus cutting off a triangular portion above the line for the insertion of the popliteus muscle. he Tline itself gives origin to part of the soleus, and the surface below the line, which is perforated by the nutrient canal, gives origin as far as its lower third to two muscles, the flexor longus digitorum chiefly, and at the outer part near the external border to the tibialis posticus.

The *lower extremity* of the tibia is somewhat larger than the shaft, and by its articulation with the astragalus is the means of transmitting the weight of the body upon the tarsus. From its inner side a triangular process of bone, termed the internal malleolus, projects downwards internal to the astragalus so as to assist in keeping that bone in position in the ankle-joint.

The inferior or articular surface of this extremity is quadrilateral, concave from before backwards but sinuously curved laterally, and extends downwards upon the outer surface of the internal malleolus. It articulates with the upper and with the internal surface of the astragalus.

The anterior surface is continuous with the anterior surface of the shaft, and is crossed by the same extensor tendons, whilst its margin also gives attachment to the anterior ligament of the ankle-joint.

The posterior surface is continuous with the posterior surface of the shaft. This aspect of the malleolus is deeply grooved by the tendons of the tibialis posticus and flexor communis digitorum muscles.

The internal surface of the extremity is subcutaneous.

The external surface is concave from before backwards for the reception of the fibula, to which it is connected by ligaments, and its margins are formed as before mentioned by the bifurcation of the external border.

The apex of the internal malleolus gives attachment to the internal lateral ligament of the ankle-joint.

## THE FIBULA. (*Plate* VIII.)

The fibula is a long and slender bone, situated upon the outer side of the leg. It is slightly curved backwards, so that from its upper to its lower extremity it becomes concave.

The head or upper extremity presents a facet upon its upper and internal part, which is directed upwards, forwards and inwards for articulation with a similar facet upon the external tuberosity of the tibia; but more posteriorly it is prolonged upwards in the form of a conical process of bone, the styloid process, to the apex of which the short external lateral ligament of the knee-joint is attached, and from whose base the soleus muscle takes origin. The outer surface of the head attaches the long external lateral ligament of the knee-joint, and gives insertion to the tendon of the biceps, whilst from the anterior part some few fibres of the peroneus longus arise.

Passing now to the shaft, four lines or ridges may be determined, none of which really extend the length of the bone, and therefore can scarcely be designated borders, but which are sufficient to separate and define certain portions or surfaces. These lines from their position may be termed anterior external and internal, and posterior external and internal, and, when recognized, the fibula, usually considered so difficult, becomes comparatively simple. From the front of the head one ridge descends for a short distance and divides into two, one of which, the anterior internal line, inclines inwards and attaches the interosseous membrane between the fibula and tibia; it is called the interosseous line, and terminates below in a rough ligamentous portion, where the two bones are connected together by a strong interosseous ligament. The other line, the anterior external, running downwards, curves outwards to the centre of the external surface of the malleolus; and about two inches above its termination a short line extends from it to the anterior border of the malleolus, and thus cuts off a portion of the bone which may be felt beneath the integument immediately above the outer side of the ankle.

By taking a posterior view of the bone, the remaining two lines may be seen. Of these the posterior external runs from the outer part of the base of the styloid process downwards to the posterior margin of the external malleolus, and is often indistinct at the upper part;

whilst the posterior internal runs from the inner part of the base of the styloid process downwards obliquely towards the interosseous line, which it may or may not join about the lower fourth of the bone.

The space between the anterior external and anterior internal lines is the anterior surface of the fibula. It is extremely narrow above but widens as it descends, and gives origin to three muscles, the extensor communis digitorum longus, peroneus tertius, and extensor proprius pollicis. The second of these is continuous with the first, and both arise as one muscle from the upper four-fifths. Internal to them and closer to the interosseous line the extensor proprius pollicis arises from the lower two-thirds.

The external surface lies between the anterior external and the posterior external lines. In the upper part it appears as a deep groove, and below turns to the back of the external malleolus, giving origin to two muscles, the peroneus longus above and peroneus brevis below. The posterior surface lies between the posterior external and the posterior internal lines. In the upper third it is much roughened, and gives origin to the soleus muscle, but in the lower two-thirds it becomes smooth, and with the exception of the lowest two inches gives origin to the flexor longus pollicis muscle.

Between the posterior internal line and the interosseous line there yet remains a longitudinally grooved portion of the bone, which occupies about two-thirds the length of the fibula. This part may be described as the internal surface, and gives origin to the tibialis posticus muscle.

The lower extremity of the fibula or external malleolus is of pyramidal form, attached to the shaft by its base. Its internal surface presents a triangular facet, smooth for articulation with the astragalus; whilst behind and below this there is a deep and rough depression for the attachment of the posterior fasciculus of the external lateral ligament of the ankle-joint. The external surface of the malleolus is divided into two parts by a prominent ridge which is continuous with the anterior external border of the shaft, namely, an anterior or subcutaneous part, and a posterior part which is continuous with the external surface of the shaft, and is grooved by the tendons of the peroneus longus and brevis in their passage to the foot.

The anterior border of the malleolus gives attachment to the anterior fasciculus of the external lateral ligament of the ankle-joint, and the apex gives attachment to the middle fasciculus of the same. The posterior border is smooth and bevelled.

## THE TARSUS. (*Plates* IX. & X.)

The tarsus is composed of seven bones: the os calcis; astragalus; scaphoid; three cuneiform, internal, middle and external; and the cuboid bone. All of these present six sides tolerably distinct.

## THE OS CALCIS, OR CALCANEUM. (*Plate* IX.)

The os calcis is the largest of the tarsal bones, and gives the form to the heel. The superior surface is divided into two unequal parts, a posterior, which is smooth, concave from behind forwards, and is occupied in the living subject by a mass of loose fat and cellular tissue; and an anterior much larger, overlapped by the astragalus, and presenting a deep groove between two articular facets. Of the two facets, both of which articulate with the astragalus, the posterior is convex for the reception of the body of that bone; whilst the anterior is elongated and concave for the reception of the head, and this projecting considerably on the inner side there takes the name of the sustentaculum tali. The anterior border of this facet gives attachment to the calcaneo scaphoid ligaments, the separating groove in direction forwards and outwards being rough for the attachment of the strong interosseous astragalo calcaneum ligament, which binds the two bones firmly together. In front of the groove the extensor communis brevis digitorum takes origin.

The inferior surface presents posteriorly two tubercles, an internal, which is large, and by its inner surface gives origin to the adductor pollicis and flexor brevis digitorum muscles, and an external, small, for the origin of the abductor minimi digiti. Between the two a deep and rough depression gives attachment to the long plantar or long calcaneo cuboid ligament. As this surface extends forwards it gradually narrows and terminates anteriorly in a third tubercle, which, together with a roughened fossa in its front, give attachment to the short plantar or short calcaneo cuboid ligament. The anterior surface is entirely smooth for articulation with the cuboid bone, and may be seen to recede above, but is prominent below. The posterior surface receives the insertion of the tendo achillis by a well-defined roughened marking at the lower part: above this it is smooth, a bursa here intervening between the tendon and the bone. The external surface is flat, but gives attachment to the middle fasciculus of the external lateral ligament by a tolerably distinct tubercle near its centre, and in front of this, in a well-marked bone, a groove may be defined separable into two parts for the transmission of the peroneus brevis above and peroneus longus below. The internal surface is smooth, and owing to the prominence of the sustentaculum tali, presents a large open space through which the posterior tibial artery and nerve together with the tibialis posticus flexor, communis digitorum and flexor longus pollicis muscles pass into the sole of the foot; the last muscle occupying a groove on the under surface of the sustentaculum near the lower part of which surface the flexor accessorius takes origin.

## THE ASTRAGALUS. (*Plate* IX.)

The astragalus is the only bone which supports the leg and transmits its weight upon the tarsus. It is not of uniform size, but presents a body, and running forwards and inwards a rounded process or head, attached to the body by a contracted portion or neck. The superior surface articulates with the tibia by a large quadrilateral smooth surface, which is broader in front than behind, so as to allow a greater amount of motion when the foot is extended; and in front of this is a rough depression upon the neck for the attachment of the anterior fasciculus of the external lateral ligament, and the anterior tibio tarsal ligament. The inferior surface articulates with the os calcis by two facets, a posterior large and concave, broader from side to side, and an anterior convex situated beneath the head, and peculiar in that a portion of it articulates, not with the os calcis, but with the calcaneo scaphoid ligament, for the purpose of increasing the elasticity of the arch of the foot. The two facets are separated by a deep depression, into which is attached the calcaneo astragaloid ligament.

The anterior surface is convex, longer in the transverse diameter, and smooth for articulation with a corresponding concavity in the posterior surface of the scaphoid bone. The posterior surface is very small from above downwards, and is occupied by a groove running inwards for the passage of the flexor longus pollicis muscle.

The external surface is almost entirely composed of a smooth triangular facet, with the base upwards, and concave from above downwards. It is very much larger than the facet on the inner surface, thus rendering the two sides of the bone easily recognized, and it articulates with the outer malleolus or inferior extremity of the fibula. To a roughened depression behind this facet, the posterior divisions of the external lateral ligament are attached.

The internal surface is small, and, by a somewhat semilunar facet at the upper border, articulates with the internal malleolus or lower extremity of the tibia, whilst its lower half is rough and gives attachment to the internal lateral ligament.

## THE SCAPHOID BONE. (*Plate* X.)

The scaphoid bone, named from its resemblance to a boat, is situated upon the inner side of the foot. Its posterior surface is pear-shaped, with the narrow extremity inwards, it is deeply concave, and forms a socket for the head of the astragalus. The anterior surface is convex from side to side, and marked by two ridges separating the whole into three facets for articulation with the three cuneiform bones. The internal surface, or, more properly speaking, the internal extremity, is rough and tuberculated, and gives insertion below to the tibialis posticus muscle.

The external surface is often marked by a facet for articulation with the cuboid bone. The superior surface is convex, and roughened by the attachment of ligaments, which pass from it to all the bones of the tarsus, and the inferior surface is somewhat flat and rough for the attachment of tarsal ligaments, especially the calcaneo scaphoid, upon which, being formed of yellow elastic tissue, depends the entire elasticity of the arch of the foot.

## The Internal Cuneiform Bone. (*Plate* X.)

The internal cuneiform bone resembles a wedge, and is situated in the tarsus, with its thin border upwards on the dorsum of the foot. The posterior surface is concave and smooth for articulation with the internal facet upon the anterior surface of the scaphoid. The anterior surface likewise presents an articular facet, but this facet is far longer from above downwards than from side to side, it is somewhat convex, and articulates with the metatarsal bone of the great toe. The external surface is that in contact with the middle cuneiform bone, with which it articulates by means of a peculiar, narrow facet, extending along the upper and the posterior borders. There is always a more or less distinctly marked facet at the anterior extremity of the upper border for articulation with the second metatarsal bone, and the rest of the surface is rough for the attachment of the interosseous ligament between it and the middle cuneiform.

The internal surface is convex from above downwards, and is marked near the lower border by a smooth surface for the tendon of the tibialis anticus to play over.

The superior portion of the bone is the sharp border of the wedge, and appears on the dorsum of the foot.

The inferior surface, or base of the wedge, projects into the sole of the foot considerably lower than either of the other cuneiform bones, and receives the insertion of the tibialis anticus, as well as a portion of the tibialis posticus.

## THE MIDDLE CUNEIFORM. (*Plate* X.)

The middle cuneiform is much the smallest of the three, and resembles a wedge with the base upwards. The posterior surface is somewhat triangular, concave from above downwards, and articulates with the central facet on the anterior surface of the scaphoid.

The anterior surface is triangular, smaller than the posterior, and articulates with the base of the second metatarsal bone. The internal surface presents an articular facet exactly corresponding to that on the outer side of the internal cuneiform bone with which it articulates. This facet is long and narrow, and occupies the posterior and superior borders, whilst the rest of the surface is rough for the attachment of the interosseous ligament.

The external surface is smooth posteriorly for articulation with the external cuneiform, rough anteriorly for the attachment of the interosseous ligament between it and the same bone.

The superior surface, or base of the wedge, is on the dorsum of the foot, and gives attachment to dorsal ligaments. The inferior aspect or edge of the wedge extends into the sole.

## THE EXTERNAL CUNEIFORM. (*Plate* X.)

The external cuneiform is intermediate in size between the other two, and resembles a wedge with its base upwards. The posterior surface articulates with the outermost facet of the scaphoid bone by a smooth facet obliquely placed from side to side and concave as though adapted to a sphere. The anterior surface is somewhat triangular and articulates with the third metatarsal bone, projecting slightly into the metatarsus between the second and fourth bones of that region.

The internal surface presents a facet upon its posterior margin elongated from above downwards, and somewhat irregular, for articulation with the middle cuneiform bone; whilst at the anterior margin there are two small facets, one above the other, and frequently united into a narrow elongated surface, for articulation with corresponding facets, or surface upon the outer side of the base of the second metatarsal bone. The rest of the surface is rough for the attachment of an interosseous ligament between the two bones. The external surface articulates with the cuboid bone by a large facet at its posterior and upper portion, and with the fourth metatarsal bone by a small facet at the upper extremity of the anterior margin.

The superior surface, which is seen on the dorsum of the foot, gives attachment to dorsal ligaments, and the inferior aspect or sharp margin of the wedge gives attachment to plantar ligaments.

### THE CUBOID BONE. (*Plate* IX.)

The cuboid is the outermost of the smaller tarsal bones. The posterior surface is altogether smooth for articulation with the os calcis, and at its inferior and inner part projects backwards so as to underlap the articular surface of that bone, and materially strengthens the joint.

The anterior or metatarsal surface articulates with the fourth and fifth metatarsal bones, and is therefore divided into two articular facets by a slight elevation, the external of the two, or that for the metatarsal bone of the little toe, being the larger.

The internal surface articulates with the external cuneiform bone by a large facet near the centre, and with the scaphoid bone by a small facet at the posterior and upper angle, the rest of the surface giving attachment to interosseus ligaments.

The external aspect of the bone approaches more to the form of a border than a surface. It is very narrow and is excavated by a groove for the tendon of the peroneus longus muscle.

The dorsal surface is slightly convex and turned considerably outwards. It is somewhat rough for the attachment of the dorsal tarsal ligament.

The plantar surface presents a deep groove running from without forwards and inwards for the passage of the peroneus longus tendon.

The posterior ridge of the groove attaches the long plantar or calcaneo cuboid ligament, and the portion of the surface behind it attaches the short calcaneo cuboid ligament.

The rest of the surface attaches ligamentous fibres which unite the tarsal bones.

## The Metatarsal Bones.

The metatarsal bones are five in number, named in order from the great to the little toe, first, second, third, fourth, fifth, and intervening in position between the small bones of the tarsus and the first row of the phalanges. Each possesses a tarsal and phalangeal extremity and shaft, and thus resembles one of the long bones on a small scale.

The tarsal extremity articulates with the tarsus by means of its terminal facet, a triangular surface with the base upwards. Each side is in contact with the adjacent metatarsal bone, and consequently possesses distinguishing articular facets. The portions of this extremity which occupy the sole or dorsum of the foot give attachment to ligaments.

The phalangeal or anterior extremity is rounded or globular, and smooth for articulation with the first phalanx, but laterally is rough, grooved, and marked by a tubercle for the attachment of ligaments.

The shaft is somewhat curved, so as to render the dorsum of the foot convex and the sole concave: it presents three surfaces, two lateral and one dorsal, the former giving origin to interosseous muscles.

The first metatarsal bone, or that of the great toe, is a large and powerfully constructed bone. It is situated at the inner side of the foot, and does not articulate with the adjacent metatarsal bone. Its tarsal articular surface is large and somewhat of a kidney shape, having its concave margin externally, and articulates only with the internal cuneiform bone.

The inferior aspect of the tarsal extremity is tuberculated and prolonged downwards into the plantar region, and gives insertion to the peroneus longus tendon.

The shaft of the bone is thick and angular. Its outer surface, which faces the second bone of the series, is curved longitudinally in a concave manner, and gives origin posteriorly to the first dorsal interosseous muscle. The head is large and broad, and has upon its plantar aspect two small depressions with which the sesamoid bones lie in contact.

The second metatarsal bone is the longest of the series. The tarsal extremity projects backwards between the bones of the tarsus and articulates with the middle cuneiform bone by its terminal triangular surface.

The outer side of this extremity presents four small articular facets, of which the two posterior, frequently unite and form a narrow elongated surface for articulation with the internal surface of the external cuneiform bone; whilst the two anterior facets are for articulation with the third metatarsal bone.

The inner side of the tarsal extremity presents only one facet at its upper angle for articulation with the outer side of the internal cuneiform bone.

The third metatarsal bone articulates by the terminal triangular surface of its base with the external cuneiform bone. Its internal side articulates with the second metatarsal bone by two facets, one above the other, corresponding to the two anterior of the four facets described on that bone. Its outer side has but one facet, for articulation with the fourth metatarsal bone.

The fourth metatarsal bone articulates by the terminal surface of its base with the cuboid bone. This surface is quadrilateral, and not triangular as the other metatarsal bones. The outer side of the base has one facet for articulation with the fifth metatarsal bone, but the inner side articulates with the third metatarsal bone, and also with the outer surface of the external cuneiform bone. It has therefore two facets, one in front of the other, and may thus be recognized from the third metatarsal bone, whose two internal facets are one above the other.

The fifth metatarsal bone may be at once recognized by its flat and extensive tarsal extremity.

The terminal surface is somewhat triangular, but elongated in the lateral direction, and articulates with the cuboid bone.

The outer side of the base projects considerably outwards and backwards, and may be termed the tuberosity. It receives the insertion of the peroneus brevis tendon.

The inner side of the base articulates with the fourth metatarsal bone by one single facet.

The shaft of this bone differs from the shafts of the remainder of the series in being flattened upon its dorsal and plantar surfaces, instead of upon its lateral surfaces.

## THE PHALANGES (TOES).

Great similarity exists between the hand and the foot with regard to the phalanges. The toes are the same in number as the fingers, and each toe, like the fingers, possesses three phalanges, with the exception of the great toe, which, corresponding to the thumb in the hand, possesses only two, the central being absent. The second toe corresponds to the third finger in muscular attachments.

A description verbatim of the digital phalanges would be equally applicable to those of the foot, the only existing differences being due to abnormal developments, in consequence of the artificial covering with which civilized man impedes the action of this otherwise useful organ.

The toes from birth are somewhat shorter than the fingers, but in an adult the second and third rows of phalanges are found to be much stunted in their growth, possessing little or no shaft, and nodulated in appearance. They are frequently also in one or more toes ossified together.

## SESAMOID BONES.

Sesamoid bones are small nodules occurring in the substance of tendons where lying in contact with bones.

The surface opposed to the bone is smooth, and resembles an articular facet, but the rest of the nodule is rounded, or irregular, and entirely covered by the fibres of the tendon. Two such small bones are found always in the tendons of the flexor brevis pollicis under the first joint of the great toe, the head of the metatarsal bone presenting a marked facet upon each side under which they glide. In the flexor brevis pollicis of the ball of the thumb two are also usually found, and occasionally in one or more of the fingers and toes in the same position. The tendon of the peroneus longus contains one of large size at the commencement of the groove in the plantar aspect of the cuboid bone; and again, where the tibialis anticus tendon lies upon the internal cuneiform bone previous to its insertion, a sesamoid bone intervenes.

The patella is but a large sesamoid bone contained in the tendon of the quadriceps extensor.

The use of these bones is for leverage, for alteration in the direction of force, and as an economical arrangement against friction.

# THE SKULL.

[In studying the separate bones of the skull, it is advisable to articulate each with those contiguous, and to have an entire skull for constant reference.]

THE skull is composed of two separate sets of bones; one set, eight in number, for the formation of a cavity in which the brain is contained, and which is designated the cranium; and another set of fourteen bones, which pertain only to the face. The eight cranial bones are the occipital, two parietal, two temporal, frontal, sphenoid and ethmoid.

## THE OCCIPITAL BONE. (*Plate* XII.)

The occipital bone assists in forming the posterior and inferior portions of the cranium, and is curved in such a manner that a part is perpendicular and a part horizontal. Looking at the bone from within, that is, its cerebral surface, it presents a marked eminence or thickened portion, the internal spine and double lines or grooves passing from this spine in a crucial manner. At this point is situated the torcular herophili, or meeting of the sinuses, one of which, the longitudinal sinus, occupies the groove which extends from the spine upwards, whilst the borders of the same attach a portion of the brain membrane, termed the falx major or falx cerebri. Two others, the lateral sinuses, occupy the transverse grooves, and their borders give attachment to the tentorium cerebelli, whilst the line extending from the spine downwards to the foramen magnum gives attachment to the falx minor or falx cerebelli, and generally encloses a short sinus termed the occipital. By means of these grooves, the cerebral surface of the perpendicular portion of the bone becomes divided into four fossæ, the upper two of which are occupied by the posterior lobes of the cerebrum, and the lower two by the hemispheres of the cerebellum. Perforating the horizontal portion is a large almost circular space, the foramen magnum, through which the spinal cord, its membranes and vessels, the vertebral arteries and spinal accessory nerves, pass. On each side of the anterior margin of the foramen magnum is a small orifice, the anterior condyloid foramen, for the transmission of the hypoglossal or ninth nerve, and more laterally, on each side of the same foramen, is a considerable projection of bone, the jugular process, which is grooved on its upper surface by a continuation of the lateral sinus already mentioned. This groove receives the posterior condyloid vein through a small foramen, and terminates in an enlarged space anteriorly, called the jugular fossa, part of which only is formed by this bone, and the remainder by the temporal. From the anterior part of the foramen the basilar process projects forwards, on the upper surface of which exists a deep longitudinal groove or furrow, corresponding in position to the medulla oblongata.

The external surface of the occiput presents an external prominence or spine at the same level as the internal, which attaches the ligamentum nuchæ, and from which a ridge, the crest of the occiput, extends downwards to the foramen magnum. Passing horizontally outwards from the spine are two superior curved lines, each giving origin to the trapezius internally, the occipito frontalis in the middle third, and insertion to the sterno cleido mastoid externally, whilst the surface above the line is smooth and covered by the occipito frontalis muscle. From the centre of the crest two other lines, the inferior curved lines, extend outwards, and each of these receives the insertion of the rectus capitis posticus minor internally, rectus capitis posticus major in the centre, and obliquus superior externally. The space between the superior and inferior curved lines receives the insertion of the complexus muscle internally, and the splenius capitis externally. Below the inferior curved line is a rough portion, part of which attaches the posterior occipito atloidean ligament, and here on the horizontal part of the bone the foramen magnum again comes into view. On each side of the foramen is situated a large eminence, the condyle elongated, convex, approaching its fellow anteriorly, and smooth for articulation with the facet of the first cervical vertebra. Each has a foramen in front and behind, the anterior and posterior condyloid foramen respectively, the former transmitting the ninth nerve, the latter a small vein from without into the lateral sinus. At the inner and anterior part of each condyle is a roughening for the attachment of the odontoid ligament. Altogether external to the condyle is the inferior surface of the jugular process, and into this is inserted the rectus capitis lateralis. The basilar process extends forwards in front of the foramen magnum, and is marked centrally by a small tubercle or spine for the insertion of the superior constrictor muscle of the pharynx, and on each side of this a depression for the insertion of the rectus capitis anticus major, and rectus capitis anticus minor. The border of the occiput is deeply serrated, and by that portion which extends from the highest point downwards to the lower border of the groove for the lateral sinus, articulates with the parietal bones, and forms with them the lambdoidal suture of the cranium. A continuation of the border as far as the jugular process articulates with the mastoid portion of the temporal bone; and the rest is opposed without articulation to the petrous portion of the same bone, except the extremity of the basilar process, which is incorporated with the body of the sphenoid bone, so that the articulations in all are with six bones, two parietal, two temporal, sphenoid, and the spinal column.

## THE PARIETAL BONE. (*Plate* XII.)

The parietal bone is quadrilateral in shape, and forms part of the upper and lateral portions of the skull on each side. Its cerebral surface is necessarily concave; it is marked by depressions corresponding to the convolutions of the brain; and it is also traversed by numerous fine grooves, corresponding to the course of the middle meningeal artery and its branches, and commencing from the anterior inferior angle of the bone. Along the upper border runs a half groove, which, being completed by a similar half groove in the other parietal bone, is continuous with the groove described on the occipital bone for the superior longitudinal sinus, but it is often very indistinct. In this part of the bone numerous small cavities may be seen, which are occupied in the recent state by small bodies connected with the dura mater, termed pacchionian glands or bodies. At the posterior inferior angle of this surface another groove, often very short, runs obliquely forwards and downwards, and when applied to the occipital and temporal bones is found to complete the channel for the lateral sinus.

The external surface of the parietal bone is convex, and apparently of increased thickness and prominence at one point, its centre of ossification. Below this the bone is crossed transversely by a curved ridge, to which a dense fascia, the temporal aponeurosis, is attached, and the remainder of the surface below the line gives origin to the temporal muscle.

The borders of the parietal bone are four in number, and of these the superior is deeply serrated, and articulates with the corresponding border of the opposite parietal bone, to form the saggital suture; and the anterior, likewise deeply serrated, articulates with the frontal bone, to form the coronal suture. The posterior border, also serrated, articulates with the occipital, to form the lambdoidal suture; and the inferior is arched and serrated posteriorly, where it articulates with the mastoid portion of the temporal bone, but in its anterior three-fourths is thin and sharp, and adapted to the inner aspect of the margin of the squamous portion of the temporal bone. A small portion at the anterior inferior angle articulates with the great wing of the sphenoid bone, so that the articulations are in all with five bones, the opposite parietal, occipital, frontal, temporal, and sphenoid.

Of the four angles of the parietal bone, the anterior and posterior superior, are in the position of the anterior and posterior fontanelles of fœtal life; the anterior inferior angle is considerably prolonged downwards and forwards, and the posterior inferior is somewhat rounded in form.

## The Temporal Bone. (*Plate* XIII.)

The temporal bone assists in forming the lateral wall and base of the skull. It is described as possessing three distinct portions, namely, a squamous or thin flat plate, nearly vertical, a mastoid or nipple-like portion projecting downwards from the posterior part, and a petrous portion, which extends inwards and forwards from the line of junction of the two preceding.

The *squamous* portion on its cerebral surface is marked by the convolutions of the brain and by fine grooves corresponding to the course of the middle meningeal artery. Its outer surface, which is comparatively smooth, forms part of the temporal fossa, and gives origin to part of the temporal muscle, whilst its circumference, which is much rounded, articulates with the lower border of the parietal bone by its upper part and with the great wing of the sphenoid by its anterior part. Arising from the lower and anterior part, and continued backwards in a line between the squamous and the mastoid portions, is a long but narrow projection, the zygomatic process. This process at its commencement is hollowed upon its under surface, as though arising by two roots, together forming an arched cavity in which the condyle of the lower jaw plays. The posterior root again appears to divide around the orifice of a canal, the external auditory meatus. At the point of junction of the two roots the process presents a tubercle, to which is attached the external lateral ligament of the lower jaw, and then extends forwards to articulate with the malar bone by a rough irregular and serrated termination. To the upper border of the process and the line which extends backwards the temporal aponeurosis is attached, and from the lower border of the process anterior to the tubercle the masseter muscle takes origin.

The glenoid cavity, into the formation of which the zygoma enters so largely, does not entirely articulate with the lower jaw, as a lower part, belonging rather to the petrous portion of the bone and formed by the vaginal process of that portion, is occupied by a process of the parotid salivary gland, and is separated from the true articular part of the cavity by a minute space, the Gasserian fissure, through which pass the chorda tympani nerve, the laxator tympani muscle and tympanic vessels, and within which is attached the processus gracilis of the malleus bone of the ear.

The *mastoid* portion is convex and rough upon its outer surface, where it is marked by the insertion of three muscles, sterno mastoid, splenius capitis and trachelo mastoid, in order from above downwards, and by one or more foramina for the transmission of veins inwards to the lateral sinus. At the lower extremity of the mastoid portion, which from its shape and appearance is called the mastoid process, is a deep indentation, the digastric fossa, from which arises the posterior belly of the digastric muscle; and internal to this the bone is often marked by a small groove for the passage of the occipital artery.

The cerebral aspect is occupied chiefly by a broad groove curving forwards and downwards, corresponding to the lateral sinus, and receiving the internal orifice of the vascular canal, previously mentioned as perforating the substance of the bone. The rest of this surface receives the lateral hemisphere of the cerebellum.

The serrated margin articulates chiefly with the occipital bone, but by a small portion at the upper extremity of the groove with the parietal.

The *petrous* portion is that part of the temporal bone which extends into the base of the skull. It is pyramidal in form, projecting from the junction of the squamous and mastoid portions horizontally forwards and inwards. It possesses a base, an apex, anterior, posterior and inferior surfaces. The base is chiefly incorporated with the rest of the bone, a large orifice, the meatus auditorius externus, alone being visible. This foramen is situated immediately behind the glenoid cavity, a thin plate of bone, termed the auditory process, to which the cartilage of the ear is attached, forming at the same time the anterior wall of the one and the posterior wall of the other. It is the external opening of the auditory apparatus, and extends as a winding canal as far as the membrana tympani or middle ear.

The apex or internal extremity of the petrous portion is partly indented for adaptation to the basilar process of the occiput, and in front of this is excavated, so as to form a boundary to a foramen in the base of the skull, termed the foramen lacerum medium. It also exhibits the termination of the carotid cavity.

The anterior surface of the petrous portion faces forwards, upwards and outwards, and assists in forming a space described as the middle fossa of the cranium. It presents close to the apex a depression corresponding to the position of the Gasserian ganglion of the fifth nerve, and below this an extremely thin plate of bone, the roof of the carotid canal, but this is often broken away. More externally upon the surface, and near the lower margin, a groove runs outwards for some short distance and perforates the substance of the bone. This groove lodges the vidian or large superficial petrosal nerve, and having entered the bone at an opening termed the hiatus fallopii, conducts it to the aqueductus fallopii, a canal containing the facial nerve. Still further outwards there is a considerable elevation upon this surface due to the position of the superior semicircular canal of the internal ear. The inferior margin of the anterior surface runs parallel to the border of the great wing of the sphenoid bone without articulation, and, where joining the squamous portion of the temporal bone, presents two small canals, one above the other, and separated from each other by a thin septum, the processus cochleariformis. The superior of these canals transmits, and gives origin to some fibres of, the tensor tympani muscle, and the inferior is the osseous portion of the Eustachian tube.

The posterior surface faces backwards and inwards, and assists in forming the posterior cranial fossa. It presents an orifice of considerable size, the meatus auditorius internus, in the depths of which may be seen numerous foramina. Of these, one, the aqueduct of Fallopius, is higher and far larger than the rest, for the transmission of the portio dura of the seventh nerve; whilst the rest are variable in size, for the passage of filaments of the auditory nerve, or portio mollis of the seventh, into the internal ear. Posterior to the meatus, a fine process of bone overhangs an elongated aperture, the external orifice of the aqueductus vestibuli, along which a small vessel passes from the vestibule of the internal ear: and near the upper border of the surface there is generally a depression which attaches the dura mater, and also probably transmits a minute nutrient vessel. The border or edge separating the anterior from the posterior surface is markedly grooved by the superior petrosal sinus, one of the venous channels in the dura mater.

The inferior surface belongs entirely to the under surface of the base of the cranium. It presents a large round orifice, the external opening of the carotid canal, which, ascending a short distance, suddenly becomes horizontal in position, and running forwards and inwards terminates in the apex of the bone, as before mentioned. The roughened surface between it and the apex gives origin to the levator palati and some fibres of the tensor tympani muscles. Immediately behind the carotid foramen are two depressions, one, the smaller, is partly visible upon the lower margin of the posterior surface, is of triangular form, and, narrowing as it deepens, terminates in a small canal, the aqueductus cochleæ, through which vessels pass to and from the cochlea. The other, external and much larger, is smooth and corresponds partly to a rough articular portion of the jugular process of the occipital bone, and partly to a similar smooth depression upon the jugular process, the union of the two bones completing an irregular space, termed the foramen lacerum posterius, or jugular foramen, where the jugular vein commences, and through which the three divisions of the eighth nerve, glosso pharyngeal, spinal accessory, and pneumogastric, leave the skull. In the wall separating the jugular fossa from the carotid canal, is a small foramen for Jacobson's nerve, the tympanic branch of the glosso pharyngeal. From the carotid canal and jugular fossa, a thin plate of bone extends towards the glenoid cavity: proceeding backwards and outwards, it partly ensheaths a conical spike of bone, the styloid process, and receives the name of the vaginal plate or process. It is here sometimes pierced by a small foramen for the passage of Arnold's auricular nerve, and afterwards becomes incorporated with the auditory process, which has been previously mentioned as forming the septum between the glenoid cavity and the meatus auditorius externus. The styloid process projects downwards, forwards and inwards, gradually lessening in size almost to a point. It is of variable length, and gives origin near its root to the stylo pharyngeus muscle, by its central and outer part to the stylo hyoid, and by its lower part to the stylo glossus, whilst at its apex the stylo hyoid ligament is attached, and in its whole length anteriorly the stylo maxillary ligament. Behind the styloid process, between it and the mastoid process, is the termination of the aqueductus fallopii, the stylo mastoid foramen, through which the facial nerve makes its exit from the skull, and a small stylo mastoid artery enters.

The margin of the petrous portion which separates the inferior from the posterior surface, presents about the centre a small excavation, really the side view of the pyramidal fossa leading to the aqueductus cochleæ. External to this it enters into the formation of the foramen lacerum posterius, and internal to it there is a half groove (not often well marked), completed by a similar half upon the basilar process of the occipital bone, for the inferior petrosal sinus.

The articulations of the temporal bone are, with the occipital, parietal, sphenoid, malar, and, as a movable joint, with the inferior maxilla.

## The Frontal Bone. (*Plate* XIV).

The frontal bone occupies the anterior part of the skull, and forms the forehead and the roof of the orbits.

Its cerebral aspect presents a horizontal portion, in which is a central deficiency for adaptation to the horizontal plate of the ethmoid bone, and, on each side of this space, a convex or elevated surface, marked by the convolutions of the brain, and contributing to form the anterior cranial fossa. The rest of the bone ascends, arching upwards and backwards, according to the curve of the forehead; and in its median line projects the frontal crest, a ridge composed of two lips which give attachment to the falx major of the dura mater. These lips slightly diverge at the lower part to form with the crista galli of the ethmoid bone a small cavity, the foramen cœcum, or a fine canal for the transmission of a vein, and broadly diverge above to form a groove for the superior longitudinal sinus. On each side of the sinus may be observed some few irregular cavities for pacchionian bodies, and further outwards grooves for the passage of meningeal arteries.

The external aspect, like the internal, presents at its lower or horizontal portion the irregular ethmoidal deficiency, and on each side of this numerous imperfect cells, which are completed by the ethmoid bone; and in front is the orifice of a large cell or space, the frontal sinus, which extends upwards into the substance of the frontal bone, between its two tables. Between the cells, courses from without forwards and inwards the anterior ethmoidal groove, for the transmission of the nasal nerve and vessels from the ophthalmic, and behind this, more or less distinctly marked, the posterior ethmoidal groove for a meningeal artery from the ophthalmic. External to the cells is a large triangular smooth and concave fossa, the roof of the orbit, and this at its exterior angle is still more deeply hollowed for the reception of the lachrymal gland. The posterior margin of the orbital surface articulates with the lesser wing of the sphenoid, but behind the outer part of this is a rough triangular surface for articulation with the great wing of the sphenoid. A well-defined smooth and thickened margin, the supra orbital ridge or arch, bounds the orbital surface in front, and extends downwards externally in the form of a thick rough projection, the external angular process for articulation with the malar bone; whilst internally in the form of a less marked projection, is the internal angular process which articulates with the lachrymal bone. This margin is perforated at its inner third by the supra orbital foramen, for the transmission of the supra orbital nerve from within the orbit and its accompanying vessels, and above the internal angular process it presents a small depression for the attachment of a fibro cartilaginous pully, over which turns the tendon of the superior oblique muscle of the globe of the eye. In the interval between the two internal angular processes, the bone is remarkably rough, and in the central line sends downwards a fine projection, the nasal spine, which is often broken away in the disarticulation, and which occupies a position in the skull between the nasal bones and the perpendicular plate of the ethmoid. The upper extremities of the nasal bones articulate with the central part of the roughened notch or interval, and the nasal process of the superior maxillary bones with the remainder. Passing now to the vertical portion of the bone, two hollow elevations curve upwards and outwards from the interval corresponding to the position of the frontal sinuses (to which spaces their prominence is due), and from them a slight elevation is continued outwards a little above and parallel to the supra orbital ridge, which is termed the supraciliary ridge, and which gives origin at its inner part to the supraciliary muscle or corrugator supercilii. From the external angular process a curved line ascends upwards and backwards, cutting off a small hollowed surface below it, which enters into the formation of the temporal fossa, and gives origin to the temporal muscle, whilst the line itself is called the temporal ridge, and attaches the temporal aponeuroses. The surface contained between the two temporal ridges forms the forehead, being convex, high or low, according to its development in different individuals. It is also smooth and covered by the occipito frontalis muscle, and presents on each side a prominence due to the commencement of ossification, termed the frontal eminence.

The serrated margin of the frontal bone articulates with the two parietal bones: the posterior margins of the orbital plates with the lesser wings of the sphenoid, and a rough triangular or quadrilateral portion external to them with the greater wings of the sphenoid: the inner margins of the orbital plates with the ethmoid: the frontal spine with the two nasal bones, and the perpendicular plate of the ethmoid: the rough interval in front of the spine with the two nasal and two superior maxillary bones: and lastly, the internal angular processes with the lachrymal bones and the external angular processes with the malar bones.

## THE SPHENOID BONE. (*Plate* XV.)

The sphenoid bone is so situated in the skull that it articulates with all the bones of the cranium, and with some of those of the face. It is of complex arrangement, and may be described as possessing a body, from the sides of which pass off two greater and two lesser wings, and from its under surface two pterygoid processes.

The body has six surfaces, bearing the same relation to each other as the sides of a cube.

The superior surface of the body resembles a Turkish saddle, sella turcica, that is, a deep central space with an elevation in front and behind. The space is called the pituitary fossa, since it lodges a portion of the brain, the pituitary gland. The posterior elevation, or dorsum ephippii, is a quadrilateral plate of bone, the upper angles of which, projecting outwards, are termed the posterior clinoid processes, and give attachment to the tentorium cerebelli of the dura mater. The anterior boundary of the fossa presents a rounded and smooth eminence, the olivary process, due to the position of the optic commissure, which corresponds to this part; and below the process on each side there is often a small tubercle, the middle clinoid process, whilst the rest of the surface above and in front of the olivary process is smooth, corresponds to the anterior lobes of the cerebrum, and is formed by the union of the two lesser wings.

The inferior surface is bounded on each side by the root of the pterygoid process, and appears in the base of the skull. It presents a central projection, the rostrum, which articulates with the vomer, and on each side of this a small groove completed as a canal by the sphenoidal process of the palate, and transmitting the pterygo palatine vessels and nerve from before backwards.

The lateral surfaces attach the greater and lesser wings, the latter by two roots, and below the pituitary fossa, they are grooved deeply by the passage of the cavernous sinus and internal carotid artery.

The posterior surface articulates with, or rather is ossified to, the termination of the basilar process of the occipital bone.

The anterior surface is very irregular. It exhibits a perpendicular lamina nearly central for articulation with the vertical plate of the ethmoid; and on each side of this is the orifice of large spaces occupying the body of the bone termed the sphenoidal cells or sinuses, the apertures being bounded below by a fine bone, the sphenoidal turbinated, which is at one time entirely distinct from the sphenoid.

The great wings project from the sides of the body outwards and upwards, possessing a cerebral, an orbital, and an external surface and a circumference.

The cerebral surface is concave and much curved upwards, forming a part of the middle fossa of the cranium, and slightly marked by the convolutions of the middle lobe of the cerebrum. At its most posterior and external part it is perforated by a small aperture, the foramen spinosum, through which the middle meningeal artery enters the skull, and more internally by one much larger, the foramen ovale, which transmits the third division of the fifth cranial nerve, or inferior maxillary, and the small meningeal artery, whilst in close contact with this there is an occasional minute foramen of Vesalius for the passage of a small vein. More anteriorly, but close to the body, is an orifice opening forwards, the foramen rotundum, for the transmission of the second division of the fifth cranial nerve or superior maxillary, and above this a large elongated open space, lying between the lesser wing above and the margin of the greater wing below, termed the foramen lacerum anterius, or sphenoidal fissure, through which the third, fourth, first division of the fifth or ophthalmic, and the sixth nerves leave the skull, and the ophthalmic vein enters.

The orbital surface looks forwards and inwards, it forms part of the outer wall of the orbit, and it is smooth, flattened, and of quadrilateral shape. By its anterior margin it articulates with the malar bone, and so completes the outer wall; its posterior or inner margin is smooth, and bounds the sphenoidal fissure below; its upper margin articulates with the orbital plate of the frontal bone; and its lower is smooth, entering into the formation of the spheno maxillary fissure. The external surface of the great wing is divided by a horizontal ridge into two parts, an upper and larger, concave from before backwards, looking outwards and forwards, and forming part of the temporal fossa, from which fibres of the temporal muscle arise; and a lower, looking directly downwards, and forming part of the zygomatic fossa from which the external pterygoid muscle arises. The extreme posterior part of this surface sends downwards a projection of bone termed the spine of the sphenoid, to which the internal lateral ligament of the lower jaw is attached, and from which the laxator tympani arises. Close to the spine is the foramen spinosum, and to its inner side the foramen ovale, seen from without.

The borders which separate the external from the cerebral surface, two in number, pass from the spine, one directly inwards towards the body, contiguous to, but not articulating with the petrous portion of the temporal bone, the other first forwards and then upwards, in a curved manner, articulating with the squamous portion of the temporal bone, and about one third of an inch at its upper extremity with the anterior inferior angle of the parietal bone. At the highest part of, and supported by, the great wing, there is a rough triangular surface for articulation with a similar surface behind the orbital plate of the frontal bone, and the three sides of this triangle are the superior marginal lines of the three surfaces of the great wing.

The lesser wings are triangular in form, with their bases at the body, and their apices extending outwards in a tapering manner. The anterior border of each is serrated, and articulates with the horizontal plate of the ethmoid by its inner part, and with the orbital plate of the frontal by its outer part. The posterior border occupies the Sylvian fissure of the brain, and its inner extremity, which is club-shaped, is termed the anterior clinoid process. The upper surface, which is continuous with that of the body and with that of the opposite wing, is smooth, and contributes to the anterior fossa of the cranium; and the inferior surface, likewise smooth, forms the upper boundary of the foramen lacerum anterius, or sphenoidal fissure. The base of the lesser wing, by which it is attached to the body, is composed of two roots, the upper of which is a thin but broad plate, which seems to extend across the body to the wing of the opposite side, whilst the lower is a narrow spicula of bone, running from the side of the body upwards to the inferior surface. By means of the two roots a circular foramen is formed, through which the optic nerve and the ophthalmic artery enter the orbit, and in front and around this foramen the muscles of the eyeball take origin.

The pterygoid processes descend from the inferior surface of the body, at its junction with the great wing. A front view presents at the root of each the anterior orifice of the vidian canal, through which the vidian vessels and nerve are transmitted, and at its outer side the bone is slightly depressed for the reception of Meckel's ganglion; about the centre the process divides into two plates, and when articulated the interval is occupied by the tuberosity of the palate bone. A posterior view presents at the root the posterior orifice of the vidian canal, and immediately below this the process is composed of two plates. Of these the external pterygoid plate is far the larger, and by its outer surface, which enters into the formation of the zygomatic fossa, gives origin to the external pterygoid muscle, and by its inner surface to the internal pterygoid muscle.

The internal pterygoid plate is narrow but long, and at its upper extremity on the outer side is marked by an elongated ovoid depression, the scaphoid fossa, from which arises the tensor or circumflexus palati muscle. At its lower extremity, on its posterior border, the superior constrictor muscle of the pharynx arises, and the extremity curves backwards in the form of a hook, the hamular process around which the tendon of the tensor palati turns inwards towards the palate. The inner surface of this plate assists in forming the outer wall of the nose.

From the foregoing description the sphenoid bone has been seen to articulate by its great wing with the temporal, frontal, parietal, and malar bones, by its lesser wing with the frontal and ethmoid, by its body with the sphenoidal turbinated (afterwards united), the vomer and palate bones, and by its pterygoid processes with the palate bones.

## The Ethmoid Bone. (*Plate* XIV.)

The ethmoid bone fills up the space in the horizontal portion of the frontal bone by means of a thin lamina, its horizontal plate, which being perforated for the transmission of the numerous filaments of the olfactoryne rve, is also termed the cribriform plate. Along the cerebral surface of the cribriform plate a fine ridge extends from behind forwards, enlarging anteriorly into a strong triangular process, the crista galli, and this process is usually surmounted by two small tubercles, which, fitting with the crest of the frontal bone, together form either a small canal for the passage of a vein, or a shallow fossa, to which the name of foramen cœcum is applied. The posterior or curved margin of the crista attaches the falx major of the dura mater, and the anterior is rough for articulation with the frontal bone at the lower termination of its crest. On each side of the crista galli are seen the many foramina, from which the name of the plate is derived, and one of them, much larger and longer than the rest, situated at the anterior part and in contact with the crista, is termed the nasal fissure, since it transmits the naso lobular branch of the ophthalmic nerve from the skull into the nose. Towards the outer part of the cribriform plate, numerous half cells exist, and are completed by similar ones upon the lower surface of the horizontal portion of the frontal bone, along the margins of the ethmoid notch. Here also (seen only in a well-marked bone) are two foramina, or grooves between the cells, anterior and posterior ethmoidal, the former transmitting the naso lobular branch of the ophthalmic nerve from the orbit into the skull, the latter a meningeal branch from the ophthalmic artery.

The posterior margin of the plate articulates with the anterior borders of the lesser wings of the sphenoid, and their extension over the body of that bone.

From the inferior or nasal surface of the cribriform plate, which presents only the lower aspect of the olfactory foramina, the remaining parts of the bone descend, namely, from the central line antero posteriorly a thin lamina, the vertical plate, and on each side of this, though not connected with it, an aggregation of cells, described as the lateral mass.

The vertical plate assists largely in forming the septum of the nose; and in substance it is extremely thin, but somewhat thickened anteriorly, and slightly bent to one side. Its upper margin is connected with the cribriform plate in the continuous line with the crista galli, and commencing from the base of that process and terminating at the posterior margin of the horizontal plate, the circumference may be divided into four parts. The first part runs obliquely downwards and forwards, and articulates with the nasal bones and nasal spine of the frontal; the second downwards and backwards, and is connected with the septal cartilage of the nose; the third, which runs upwards and backwards, articulates with the superior border of the vomer; whilst the fourth is continuous with the central longitudinal lamina upon the body of the sphenoid bone, its slant depending upon fracture rather than upon disarticulation.

The lateral mass presents upon its outer surface a quadrilateral smooth plate of bone, the os planum, or orbital plate of the ethmoid, which assists in forming the inner wall of the orbit, and articulates with the lachrymal bone by its anterior margin, the latter bone completing the imperfect cells in front of the plate. The posterior margin of the os planum articulates with the sphenoid bone; the superior with the orbital plate of the frontal, where, when perfect, may be seen two orifices, the anterior and posterior ethmoidal foramina; and the lower margin articulates chiefly with the orbital surface of the superior maxillary bone, so that the half cells below the os planum become completed: amidst these cells a process extends downwards and communicates with the inferior turbinated bone. A small portion, however, of this margin, posteriorly together with one or more half cells, is attached to the ethmoidal surface of the anterior process of the palate bone. At the anterior extremity of each lateral mass, there are often imperfect cells which are completed by the nasal process of the superior maxillary bone, and, at the posterior extremity, one or more large cells completed by the sphenoidal turbinated bones.

The cellular mass is composed of two distinct sets of cells, an anterior and a posterior, totally unconnected with each other, and opening into different spaces within the nasal cavity. One of the anterior cells becoming united with the duct of the frontal sinus, produces a tube of funnel shape, termed the infundibulum.

From the internal surface of the lateral mass two thin and curled plates of bone curve inwards and downwards, their long diameters being from before backwards. They are well seen in a posterior inferior view of the ethmoid, and, from their peculiarly wrinkled or spongy appearance, are termed the turbinated or spongy bones.

The superior turbinated bone is much the smaller of the two, and is situated on the posterior part of the ethmoid, not extending more forward than the centre, and it curves over a space described as the superior meatus of the nose, in which may be seen the orifice of the posterior ethmoidal cells. The lower is called the middle turbinated (since a third, the inferior turbinated, exists, but is not a portion of the ethmoid), and it overhangs the middle meatus of the nose, into which open the anterior ethmoidal cells and the infundibulum. This bone is larger in front than behind, and articulates posteriorly with a horizontal ridge upon the palate bone, and anteriorly with a continuation of that line forwards upon the nasal process of the superior maxilla. The ethmoid articulates with fifteen bones:—with the sphenoid by its perpendicular and horizontal plates, and also by the lateral masses; with the sphenoidal turbinated by the lateral masses; with the frontal bone by the horizontal plate and crista galli; also with the frontal spine by the perpendicular plate; with the palate bone by the orbital plate and by the middle turbinated; with the superior maxilla by the orbital plate; also with the nasal spine of the superior maxilla by its anterior cellular mass; with the lachrymal by the cellular mass in front of the orbital plate; with the inferior turbinated by a process from the cellular mass; with the nasal by its perpendicular plate; and with the vomer by its perpendicular plate.

## THE BONES CONSTITUTING THE FACE.

The bones of the face are fourteen in number, of which the inferior maxilla and vomer are single; the rest being arranged in six pairs, superior maxillary, malar, palate, lachrymal, nasal and inferior turbinated.

### THE SUPERIOR MAXILLARY BONE. (*Plate* XVI.)

The superior maxilla occupies one side of the face between the orbit and the mouth. It presents an internal aspect, entering into the formation of the nasal and oral cavities, and an external aspect which, in consequence of a considerable prominence, the malar process, exhibits three distinct surfaces, a facial, a zygomatic and an orbital.

The internal aspect enters more largely into the cavity of the nose than into that of the mouth, the two cavities being separated from each other by a horizontal plate of bone, the palatine process, which is situated near the lower part of the surface, and which extends inwards in such manner that it becomes a portion of the floor of the nose and roof of the mouth.

The palatine process does not extend the entire length of the bone from before backwards, but leaves a considerable space posteriorly which is occupied by the horizontal plate or palatine process of the palate bone. The upper or nasal surface of the palatine process is smooth and concave from side to side, but the lower or oral surface is arched in the shape of the roof of the mouth, and is much roughened for the attachment of an extremely thick glandulous mucous membrane, whilst it is also traversed by a groove from behind forwards for the passage of the posterior palatine vessels and nerves. The palatine process, which is continuous with the rest of the bone both externally and anteriorly, possesses only two free margins, a posterior which articulates with the horizontal plate of the palate bone, and an internal which thickens considerably as it extends forwards and becomes incorporated with the alveolus. Anteriorly it is deeply grooved by a canal, the naso palatine, running from the nose into the mouth for the transmission of the naso palatine vessels and nerve. This border is elevated in the nasal cavity in the form of a crest, which articulates with the vomer, and extends forwards beyond the nasal orifice as a fine and sharp point, the anterior nasal spine.

That portion of the internal aspect of the superior maxilla below its palatine process corresponds to the roof of the mouth, and is rough for the attachment of the thick mucous membrane there found, and is often grooved by small vessels and nerves, branches chiefly of the posterior palatine.

The nasal division of the internal aspect of the superior maxilla, or that portion above the palatine process, belongs entirely to the outer wall of the nose.

The posterior half of this surface presents most conspicuously a large and irregular aperture leading into a cavity of considerable size, the antrum of Highmore, and which aperture is almost entirely closed when the ethmoid inferior turbinated and palate bones are in position, a small orifice at its upper and anterior part alone remaining as a permanent communication between the space and the middle meatus of the nose. The antrum is somewhat pyramidal in shape, with its apex extending outwards into the malar process, so that its three walls correspond to the three surfaces upon the external aspect of the bone. Immediately above the aperture of the antrum are several half cells, one of which, the most posterior, is completed by the anterior process of the palate bone, and the rest by the lower part of the lateral mass of the ethmoid. Below and behind the aperture the surface is rough, for articulation with the palate bone. This is particularly the case in a line continuous with the palatine process, where the horizontal plate of the palate bone articulates, and so completes the separation between the nose and mouth; but it is less rough behind, where the perpendicular plate of the palate bone articulates, or rather is adapted, overlapping some considerable portion of the aperture itself. In this latter region a groove may be frequently observed, which being completed as a canal by the perpendicular plate of the palate, transmits the posterior palatine vessels and nerve; and often two such grooves exist. In front of the antrum a deep groove, the lachrymal duct, descends from the orbit somewhat obliquely backwards and inwards, to the inferior meatus of the nose; and it is completed as a canal by the lachrymal and inferior turbinated bones; extending from the duct horizontally forwards to the anterior margin of the surface is a small marked ridge for articulation with the inferior turbinated bone, and the whole of the surface below the ridge is smooth and grooved, forming the outer wall of the inferior meatus, or sinus of the nose. From this line a portion of the bone ascends considerably higher than the rest, termed the *nasal process*, the inner surface of which is continuous with the inner aspect of the bone, and presents a second horizontal ridge, running parallel with the first. It articulates with the middle turbinated bone, and the surface between the two becomes the outer wall of the middle meatus or sinus of the nose. Above the middle turbinated ridge, the surface enters into the formation of the outer wall of the nose, and at its posterior portion presents one or two half cells, completed by the ethmoid.

The external surface of the nasal process is continuous with the facial surface of the external aspect: it is comparatively smooth, and gives origin to the levator labii superioris alæque nasi. The upper extremity or apex is very rough, and often a little clubbed, articulating with the rough interval between the internal angular processes of the frontal bone. Of the borders of the nasal process, the anterior is thin, and articulates with the nasal bone. The posterior is thick, and breaks up into two diverging ridges, one of which, the external, runs outwards to become continuous with the inferior orbital ridge, and presents a small tubercle, which may be taken as a guide to the lachrymal duct; whilst the other, or internal ridge, articulates with the lachrymal bone, and thus encloses the lachrymal duct.

The external aspect of the superior maxillary bone has already been said to present three surfaces, due to the pyramidal prominence of the malar process.

The malar process is not composed of solid bone, but contains within its walls, which are comparatively thin, the spacious cavity, or antrum of Highmore, previously described. At the apex it is stout, rough and indented, for articulation with the malar bone, the roughness extending also from the apex inwards in the course of the inferior orbital ridge.

The anterior or facial surface presents near the upper margin the infra orbital foramen, or anterior orifice of a canal which transmits the infra orbital nerve, a branch of the superior maxillary or second division of the fifth, and the infra orbital artery. Above the foramen the levator labii superioris takes origin, and below it the levator anguli oris. Here the surface is markedly hollowed, and receives the name of the canine fossa, and close to the anterior border of the surface, a little below the level of the infra orbital foramen, the compressor naris arises. Approaching the lower margin of the same surface, a smaller concavity may be observed situated above the incisor teeth, termed the myrtiform fossa, from which the depressor alæ nasi takes origin. The facial surface is excavated at its anterior border, in the position of the anterior orifice of the nose.

The posterior or zygomatic surface is convex; it enters into the formation of the zygomatic fossa; and it is perforated by foramina for the posterior dental vessels and nerves in their passage to supply the molar teeth. Near the lower part there is a prominence, termed the tuberosity of the maxilla, due to the position of the wisdom tooth: and upon the surface, above the molar teeth, the buccinator muscle takes its origin.

The superior or orbital surface forms the floor of the orbit and roof of the antrum. It is triangular in form and is smooth, and at its anterior margin elevated for the formation of the inferior orbital ridge, the outer half of which is rough, and completed by the malar bone. Its external margin is bevelled and contributes to form the spheno maxillary fissure; and the internal is irregular and articulates with three bones, the lachrymal in front, the os planum of the ethmoid in the centre, and the anterior process of the palate bone posteriorly. Across the orbital surface a canal, the posterior part of which is usually uncovered, runs forward to terminate at the infra orbital foramen, transmitting the same structures, thei nfra orbital nerve and artery. From the nerve anterior dental filaments extend downwards through minute canals in the anterior wall of the antrum of Highmore to supply the incisor teeth. The inner angle of the surface is deficient, this being the position of the lachrymal duct, and in the neighbourhood is a depression from which the inferior oblique muscle of the eye arises.

The base, or lower, or alveolar border of the superior maxilla, consists of a number of cavities, the alveoli, separated from each other, and surrounded, by thin laminæ of bone, the alveolar processes. The cavities are eight in number, corresponding to the teeth, and divided for the reception of their respective fangs; whilst the alveolar processes present innumerable vascular pores or foramina, which give them a spongy appearance.

The superior maxillary bone articulates with its fellow of the opposite side by the alveolar border and palatine process; with the vomer by the palatine process; with the palatine bone by palatine process and internal surface; with the ethmoid by the internal surface above the aperture of the antrum of Highmore, and by the nasal process; with the lachrymal bone by the same parts; with the inferior turbinated by the internal surface; with the nasal bone by nasal process; with the frontal bone by nasal process; and with the malar bone by the malar process.

## The Malar Bone. (*Plate* XVII.)

The malar bone is of tabular form and quadrilateral. It enters largely into the composition of the orbit, and bounding the face laterally produces the high or low cheek of different individuals. It presents two surfaces and four borders.

The external surface is convex, and is perforated by small canals for the passage of malar branches of nerve and vessels. Near the upper border it is covered by the orbicularis palpelrarum muscle, and near the lower gives origin to two muscles, zygomaticus major and zygomaticus minor, the latter being more anterior.

The internal surface enters into the formation of the temporal and zygomatic fossæ, for which purpose it is smooth and concave, but at its anterior extremity it becomes rough and uneven for articulation with the malar process of the superior maxilla.

The four borders are named according to their position, orbital, maxillary, temporal and zygomatic.

The orbital border forms the outer, and chief part of the inferior margin of the orbit, and articulates at its upper extremity with the external angular process of the frontal bone, and at its lower with the inferior orbital ridge of the superior maxilla. From it a thin plate extends backwards, which articulates with the orbital plate of the superior maxilla below and with the orbital plate of the sphenoid bone by its posterior margin, a small portion entering into the spheno maxillary fissure (unless the orbital surface of the sphenoid articulates with the superior maxilla); and at the upper part it articulates with the orbital plate of the frontal bone.

The maxillary border is rough for articulation with the malar process, and the rough anterior margin of the orbital surface of the superior maxilla.

The temporal border bounds the temporal fossa, and gives attachment to the temporal aponeurosis; whilst at its lower part it becomes continuous with the upper border of the zygomatic process of the temporal bone: a serrated angle or process of bone separates the zygomatic from the temporal border, and articulates with the anterior extremity of the zygomatic process of the temporal bone.

The zygomatic border is continuous with the lower border of the zygomatic process of the temporal bone, and gives origin to fibres of the masseter muscle.

The malar bone articulates very largely with the superior maxilla by its internal surface, maxillary border, and orbital process; with the sphenoid by its orbital process; with the frontal by its orbital border and orbital process; and with the temporal by the serrated angle or process, sometimes called the zygomatic process of the malar.

## THE PALATE BONE. (*Plate* XV.)

The palate bone occupies a position internal to the superior maxilla. It is composed of two plates, one horizontal, the other verticle, and a tuberosity which projects backwards, downwards and outwards from their point of junction.

The horizontal plate is quadrilateral and it continues backwards the plane of the palatine process of the superior maxilla, with which it articulates by its anterior border, thus completing the separation of the nose from the mouth. By its internal border it articulates with the horizontal plate of the opposite palate bone, the union of the two forming a groove upon the upper aspect for the reception of the lower margin of the vomer.

The external border is incorporated with the perpendicular plate of the bone; and the posterior, which is extremely thin, forms the boundary of the hard palate and gives attachment to the soft. This border is concave, and the inner point, uniting with that of the opposite side, projects backwards as a sharp process, the posterior nasal spine.

Of the two surfaces of the horizontal plate, the superior or nasal is smooth and concave from side to side, the inferior or oral is rough and marked posteriorly by a transverse ridge into which is inserted the circumflexus or tensor palati muscle. At the outer extremity of the ridge appears one large foramen, often more than one, of smaller size, the orifices of the posterior palatine canals for the transmission of vessels and nerves of the same name; whilst running forwards from the foramina is a groove which conducts these structures to the front of the hard palate.

The vertical plate is extremely thin and fragile and extends upwards at a right angle to the horizontal plate. Its external surface is applied to the inner aspect of the superior maxilla with which it altogether articulates, and is usually traversed by a fine groove in direction downwards and slightly forwards, which, when completed by a similar groove upon the maxilla, forms the posterior palatine canal, the inferior orifice of which was seen on the under surface of the horizontal plate. The internal surface is marked by two horizontal ridges, one above the other, corresponding to those on the inner surface of the nasal process of the superior maxilla, and like them articulating the inferior with the inferior turbinated bone and the superior with the middle, while the surface below each ridge is concave from above downwards and enters into the formation of the outer wall of the inferior and middle meatus of the nose respectively.

The vertical plate of the palate bone extends forwards at its anterior border, so as to assist in forming an inner wall to the antrum, thus materially lessening the orifice of that space. From the upper border project two processes, an anterior, orbital, and a posterior, sphenoidal, separated from each other by an interval or space, the spheno palatine notch or foramen, through which pass the spheno palatine vessels and nerves.

The anterior or orbital process is of variable size, containing within its substance one or even two small cells. In consequence of its enclosed position it articulates with other bones in three directions, and in addition assists in the formation of two spaces: thus possessing in all five surfaces. The articulating surfaces are, an anterior with the superior maxilla immediately below and behind the orbital surface of that bone, a posterior with the sphenoidal turbinated bone, and an internal with the ethmoid at the posterior inferior angle of the os planum. The surfaces entering into the spaces are the superior, triangular in form, at the extreme posterior part of the floor of the orbit; and the external in the spheno maxillary fossa.

The posterior or sphenoidal process curves inwards and backwards beneath the body of the sphenoid bone, with which it articulates by its superior surface, thus forming a floor to the pterygo palatine canal. The inferior surface is smooth and concave, and bounds the nares, whilst an external surface is directed into the spheno maxillary fossa at its anterior part, but extends backwards so as to overlap some portion of the internal pterygoid plate.

The tuberosity of the palate bone is a somewhat conical process projecting backwards, downwards and outwards, from the angle of junction of the vertical with the horizontal plate. It enters between the two plates of the pterygoid process of the sphenoid bone, and presents on its posterior aspect a central smooth groove for the completion of the pterygoid fossa, to the inner side of which is a second groove, deeper but rougher, for the reception of the internal pterygoid plate, and to its outer side a rough margin for articulation with the external pterygoid plate. The outer surface of the tuberosity is rough and uneven, for articulation with the part of the tuberosity of the superior maxilla.

The palate bone articulates largely with the superior maxilla by its perpendicular plate and tuberosity; with the two turbinated bones by the inner surface of the perpendicular plate; with the sphenoid by its sphenoidal process and by its tuberosity; with the sphenoidal turbinated and ethmoid by the orbital process; with the opposite palate, and with the vomer by the internal margin of the horizontal plate.

## THE LACHRYMAL BONE. (*Plate* XVII.)

The lachrymal bone, also termed the os unguis, from a supposed resemblance to a finger nail, is a small and thin bone, situated at the anterior part of the inner wall of the orbit. It possesses two surfaces and four borders.

The external surface looks into the orbit, and is divided by a perpendicular ridge into two portions, of which the anterior and smaller is in the form of a groove, and assists in forming the lachrymal canal; whilst the posterior, larger and flat, contributes to the inner wall of the orbit.

The internal surface is considerably hollowed in an angular manner, having the appearance of two laminæ of bone united together at an angle; the anterior contributing to the middle meatus of the nose, and the posterior closing in cells upon the lateral mass of the ethmoid. Frequently a half cell at the upper part of this surface completes a similar one upon the frontal bone.

Of the borders, the superior is short, but thick and serrated, and articulates with the frontal bone posterior to the junction of that bone with the nasal process of the superior maxilla. The inferior is divided into two parts, an anterior, corresponding to the lachrymal groove, and extending downwards to articulate with the inferior turbinated bone, thus completing the lachrymal canal; and a posterior portion, which articulates with the orbital plate of the superior maxilla. The posterior border articulates with the os planum of the ethmoid, and the anterior border with the posterior margin of the nasal process of the superior maxillary bone.

## THE NASAL BONE. (*Plate* XVII.)

The nasal bones are two small quadrilateral bones, which when united together form the bridge of the nose, and for that purpose are placed in an oblique position. Each presents two surfaces and four borders.

The anterior or external surface is smooth and concave from above downwards. It is covered by the pyramidalis nasi muscle, and perforated by one or more vascular foramina.

The nasal surface is convex, and, by a small portion near the upper extremity of the bone, assists in closing the frontal sinus: the remainder enters into the roof of the nose, and is frequently marked by a longitudinal groove, along which the naso lobular nerve courses to the extremity of the nose. Of the borders the superior is small, but thick and stunted, and is serrated for articulation with the central rough notch of the frontal bone. The inferior is thin, curved, or irregular, and is connected with the lateral cartilage of the nose.

The anterior or internal border is very thick and flat, perfectly straight and central, and, when compared with the external border, tolerably smooth; it articulates with its fellow bone, and posteriorly is in contact with the nasal spine of the frontal. The external border is longer and much thinner than the internal; it slants obliquely outward, and it is rough for articulation with the anterior border of the nasal process of the superior maxilla.

## THE INFERIOR TURBINATED OR SPONGY BONE. (*Plate* XVII.)

The inferior turbinated bone is of a coiled up and spongy appearance; it is contained within the cavity of the nose, and over-roofs a space described as the inferior meatus. It presents an external surface, concave, and an internal surface, convex, spongy, and grooved by blood vessels. The anterior extremity of the bone is thin and rounded, but the posterior projects backwards in the form of a point. The inferior border is thick and spongy, and lies free within the cavity of the nose, but the superior border is the part which holds the bone in position by its numerous articulations. Most anteriorly this border is attached to a horizontal ridge, situated at the base of the nasal process of the superior maxilla; behind this a triangular process ascends to meet the lachrymal bone, and assists in forming the lachrymal canal; still more posteriorly a thin plate of bone curls over and descends upon the inner wall of the antrum of Highmore, by which a communication also takes place with the lateral mass of the ethmoid bone; and, lastly, behind this a thin edge is connected with the inferior turbinate ridge of the perpendicular plate of the palate bone.

## The Vomer. (*Plate* XVII.)

The vomer is the thin perpendicular plate which contributes so materially to the septum of the nose. Its name signifies a ploughshare, but it is quadrilateral in form, with an expansion upon its upper border. The two surfaces of the bone resemble each other, with the exception that one, usually the left, is convex, and the other concave, owing to the bone being more prominent in the one than in the other nasal cavity. Each then is grooved by the passage of blood vessels and nerves, and one groove, larger and deeper than the rest, extends downwards and forwards, transmitting the naso palatine nerve.

The superior border is short but thickened, and spreads out on each side in the form of two alæ, which, when the bone is articulated, embrace the rostrum of the sphenoid bone, and extend laterally as far as the sphenoidal process of the palate bone.

The inferior border fits into the groove formed by the junction of the two palatine processes of the superior maxillary bones, and the two horizontal plates of the palate bones.

The posterior border is sharp and almost perpendicular; it separates the posterior orifices of the nares one from the other.

The anterior border has a very oblique direction, downwards and forwards, and usually presents a separation of the two surfaces of the bone, thus producing a space or groove for the reception of the perpendicular plate of the ethmoid, and in front for the septal cartilage of the nose.

## THE INFERIOR MAXILLA. (*Plate* XVI.)

The entire lower jaw is formed by one bone, the inferior maxilla, and this may be described as possessing an arched body, or central portion, from the extremities of which ascend two quadrilateral appendages, the rami.

The body is curved upon itself, so as to present an anterior convex and a posterior concave surface, and an upper and lower border.

The convex surface is marked in the centre by a vertical prominence, the symphysis or original separation of the bone into two parts, and on each side of this, by a slight depression, the mental fossa, from which arises the levator menti muscle: still more externally, about the level of the second bicuspid tooth, a foramen of some considerable size, the mental foramen, extends into the substance of the bone to the dental canal, and transmits to the surface mental branches of nerve and vessels derived from the inferior dental. An oblique line, more or less distinctly marked, extends from or near the symphysis backwards and upwards to the anterior border of the ramus. It is designated the external oblique line, and gives origin above to the quadratus menti, or depressor labii inferioris, and behind this to the depressor anguli oris, receiving below the insertion of the platysma myoides.

Between the oblique line and the molar teeth the buccinator muscle arises.

The concave surface presents a central perpendicular marking, either elevated or depressed, which may be recognised as the symphysis, and at its lower point an elevation composed of four tubercles, arranged in two pairs, for the origin, the upper of the genio hyo glossus, and the lower of the genio hyoid muscles; whilst below the tubercles, encroaching on the lower border are two fossæ, one on each side, for the origin of the anterior belly of the digastric muscle. A depression of considerable extent, though shallow, exists on each side of the tubercles in the position of the sublingual gland, hence termed the sublingual fossa; and from this an elevated ridge, the internal oblique line, or mylo-hyoid ridge, extends upwards and backwards towards the ramus. This line gives origin to the mylo-hyoid muscle, and at its posterior extremity, also to fibres of the superior constrictor muscle. The surface below the line is in contact with the submaxillary gland, and from that circumstance is termed the submaxillary fossa. The upper border of the bone is composed of deep cavities, sixteen in number, the alveolar spaces, separated from each other, and surrounded by fine laminæ, the alveolar processes, and perforated by innumerable vascular foramina. The spaces are adapted in size and form to the respective teeth by which they are occupied. The lower border is smooth, rounded, and subcutaneous in the whole of its extent; and at its junction with the ramus it is grooved by the facial artery in its passage on to the cheek.

The ramus extends upwards from the body at an angle, the degree of which varies with the age of the individual, being very obtuse in early life, but gradually approaching a right angle towards adult age.

The external surface of the ramus is continuous with the convex surface of the body. It is somewhat rough in appearance, and receives upon its lower three-fourths the insertion of a large muscle of mastication, the masseter:

and above this and near the posterior part the external lateral ligament of the lower jaw is attached.

The internal surface of the ramus presents near the centre the large orifice of the inferior dental canal, through which the inferior dental vessels and nerve pass for the supply of the lower teeth. A small but distinct groove extends downwards from the foramen, to conduct from the vessels and nerve a small branch, the mylo-hyoid, to supply the muscle of the same name. The anterior border of the foramen is formed by a sharp point of bone, the vaginal process, to which the internal lateral ligament of the lower jaw is attached; and below the foramen the surface is rough for the insertion of the internal pterygoid muscle.

The posterior border of the ramus is smooth and rounded, giving attachment to the stylo maxillary ligament.

From the superior border ascend two processes, the posterior for articulation, termed the condyle, and the anterior or coronoid process, separated from each other by an interspace, the sigmoid notch.

The condyle is a convex articulating process, adapted to the anterior half of the glenoid cavity of the temporal bone, and is therefore longer from side to side than from before backwards. As the condyloid process verges into the ramus it contracts considerably, so that the articulating portion becomes supported upon a neck, which it overhangs in front so as to produce a fossa, into which is inserted the external pterygoid muscle.

The coronoid process is of triangular form, with the apex directed upwards. Upon its external surface it is flat and smooth, but internally it is rough for the insertion of the temporal muscle; and its anterior margin divides into two ridges, one passing each side of the teeth.

The sigmoid notch or space between the two processes simply transmits the masseteric vessels and nerve, for the supply of the masseter muscle.

The inferior maxillary bone articulates with the two temporal bones only, and the joint is one of the few that possess an inter-articular fibro-cartilage.

## THE SKULL EXAMINED AS A WHOLE.

The vault or arched roof of the skull comprises portions of the frontal, of the parietal, and of the occipital bones. It is of an arched form, and exhibits along its centre, from before backwards, the sagittal suture, or union of the parietal bones, at the anterior extremity of which, and at right angles to it, is the coronal suture or junction of the frontal with the parietal bones, and at the posterior extremity the lambdoidal suture, passing obliquely downwards upon each side between the occipital and parietal bones. At the two extremities of the sagittal suture are found, in the foetus, the anterior and posterior fontanelles respectively.

Wormian bones are found more or less frequently in the various sutures of the cranium, and consist of small but distinct bones ossified from a separate and special point.

The internal surface of the vault presents the same sutures, and, in elderly subjects, scattered here and there a variable number of depressions, occupied by small bodies, described as Pacchionian glands.

The surface is impressed by the convolutions of the brain, and grooved by the middle meningeal artery.

### The Inferior Region. (*Plate* XVIII.)

The inferior region is of large extent, and includes all the points within a quadrilateral space, the diameters of which run, one from the incisor teeth to the occipital protuberance, and the other from one mastoid process to the other. In the front part, surrounded by the teeth of the upper jaw, is the roof of the mouth, composed of the palatine processes of the superior maxillary bones, and behind these the horizontal plates of the palate bones, which unite together in the median line.

The median suture presents at its anterior extremity the orifice of the anterior palatine canal, for the transmission of a nerve and vessels of the same name, and at its posterior extremity a sharp process, the posterior nasal spine. The horizontal plates of the palate bones are joined to the maxilla by what is termed the transverse suture, and are marked by a transverse ridge, and at their external extremity by one or more foramina for the posterior palatine vessels and nerves.

Behind the palate the posterior orifices of the nares come into view, separated from each other by the free margin of the vomer, and bounded above by the body of the sphenoid, ala of vomer and sphenoidal process of the palate bone, together forming the pterygo palatine canal; below by the horizontal plate of the palate bone; and externally by the pterygoid processes.

The pterygoid process consists of two plates: the internal is small and thin; it is curved and prolonged at its inferior extremity, the hamular process, around which turns the tensor or circumflexus palati muscle, and it is marked above by a depression, the scaphoid fossa, for the origin of the same muscle. The external plate, the larger, gives origin by its internal surface to the internal pterygoid muscle; and by its outer surface, which enters into the zygomatic fossa, to the external pterygoid.

The space between the two plates, known as the pterygoid fossa, is completed by the tuberosity of the palate bone. In the root of the pterygoid process is the posterior orifice of the vidian canal, often difficult to be seen in this view. External to the pterygoid process, in the great wing of the sphenoid bone, is the foramen ovale, for the transmission of the third division of the fifth nerve, and the small meningeal artery; next to this, the foramen spinosum, through which the middle meningeal artery enters the skull, and still more externally the spine of the sphenoid bone.

Commencing again in the median line we come upon the basilar process of the occipital bone, which gives insertion by a tubercle (its spine) to the superior constrictor muscle of the pharynx, and, by a depression on each side of the spine, to the rectus capitis anticus major and minor muscles of the right and left sides respectively. External to the basilar process, and fitting into the angle between it and the sphenoid bone, is the petrous portion of the temporal bone. This does not however articulate, but leaves a space, the foramen lacerum medium, occupied in the recent state by a fibro-cartilage. Following now the temporal bone from within outwards, the points of notice are, first, the rough surface for the origin of the levator palati and tensor tympani muscles, next, a circular foramen, the inferior orifice of the carotid canal, and behind this, formed partly by the petrous portion of the temporal, partly by the occipital bone, the jugular foramen or foramina lacerum posterius, through which the jugular vein and the three divisions of the eighth nerve leave the skull. Moreover, behind the carotid canal is a conical fossa, contracting in its depths into a little canal, the aqueductus cochleæ, and in the wall which separates the carotid canal from the jugular fossa, a minute foramen for Jacobson's nerve. Next in order, the vaginal process proceeds outwards and bifurcating encloses the styloid process; whilst external to this is the stylo mastoid foramen, or termination of the aqueductus Fallopii, the passage of the portio dura of the seventh nerve. This aspect of the mastoid process is deeply grooved by the digastric fossa for the origin of the posterior belly of the digastric muscle, and running internal and parallel to the fossa is a small groove, more or less marked, in which lies the occipital artery. In front of the vaginal process is the glenoid cavity, separated into two parts by the Glasserian fissure, an anterior, occupied by the condyle of the lower jaw, and a posterior, occupied by a process of the parotid gland. The fissure itself gives exit to the chorda tympani nerve, the laxator tympani muscle and a tympanic artery, and just at its inner extremity, in the angle between the squamous and petrous portions, a bristle may be passed into two canals, one above the other, the lower being the Eustachian tube, the upper, the canal for the passage of the tensor tympani muscle. Again, returning to the median line, may be seen behind the basilar process the large aperture, the foramen magnum, through which the spinal cord and its vessels leave the skull, and the vertebral arteries and spinal accessory nerves enter it. On each side of the foramen is the condyle of the occiput, convex, elongated in shape, and approaching its fellow at its anterior extremity; in front and behind it are the anterior and posterior condyloid foramina, and some little distance to its outer side is the jugular process of the occiput, into which the rectus capitis lateralis is inserted. Behind the foramen magnum the crest of the occiput ascends towards the external protuberance of the same bone, and upon each side of it pass off the inferior and superior curved lines, the former receiving the insertion of the rectus capitis posticus minor and major muscles, as well as the inferior oblique; the latter giving origin to the trapezius and the occipito frontalis, and insertion to the sterno mastoid, whilst the interval or space between the two lines gives insertion to the complexus and splenius capitis.

## The Cranial Fossæ. (*Plate* XVIII.)

The cerebral aspect of the base of the skull, similar upon the two sides, presents two projecting borders, dividing the whole into three fossæ, each of which receives a separate portion of the brain substance, namely, the anterior and middle fossæ, the corresponding lobes of the cerebrum, and the posterior fossa, the lateral hemisphere of the cerebellum.

*The anterior fossa* is formed chiefly by the upper surface of the orbital plate of the frontal bone, having a portion of the horizontal plate of the ethmoid bone internally, and the lesser wing of the sphenoid bone posteriorly. It is therefore elevated, convex, and marked by the cerebral convolutions, and also by fine grooves for meningeal arteries. The fossa is separated from its fellow of the opposite side by the crista galli, which gives attachment to the falx major, and forms at its anterior extremity a small aperture, the orifice of the foramen cœcum. At the side of the crista galli is the cribriform plate of the ethmoid, with its numerous foramina for the transmission of the divisions of the olfactory nerve, for the trunk of which there is frequently a groove extending backwards over the body of the sphenoid bone. One of the apertures, close to the crista and near its anterior extremity, is of a fissure-like form, and transmits the naso lobular branch of the ophthalmic nerve into the cavity of the nose. At the junction of the ethmoid with the orbital plate are two foramina, the orifices of the anterior and posterior ethmoidal grooves, the former of which transmits the nerve just mentioned from the orbit into the skull, and the latter a small meningeal artery in the same direction.

*The middle fossæ* of the two sides communicate with each other across the pituitary fossa on the body of the sphenoid bone; there is therefore a portion in the central line which may be said either to belong to both fossæ or to neither, namely, the pituitary fossa or sella turcica. This part is bounded posteriorly by the dorsum Ephipii; anteriorly by the olivary process, surmounted by the optic groove, which extends forwards and outwards on each side to the optic foramen; and laterally by the groove for the cavernous sinus and internal carotid artery.

The remainder of the middle fossa is formed by the greater wing of the sphenoid bone, and by the petrous and squamous portions of the temporal bone, upon each of which the distinctive points must be separately enumerated.

On the anterior wall, between the greater and lesser wing of the sphenoid bone, is the foramen lacerum anterius, or sphenoidal fissure, opening into the orbit, and transmitting the third, fourth, first division of fifth, and the sixth nerve and the ophthalmic vein. Below the inner extremity of the sphenoidal fissure is the foramen rotundum, through which the superior maxillary or second division of the fifth nerve leaves the skull; and behind and external to this the foramen ovale, transmitting the inferior maxillary or third division of the fifth nerve and a small meningeal artery, the latter into the skull. External to the foramen ovale the middle meningeal artery enters the skull through the foramen spinosum.

The posterior part of the middle fossa is formed by the anterior surface of the petrous portion of the temporal bone, at the inner extremity of which is the foramen lacerum medium, an aperture leading through the base of the skull, but occupied only by a fibro cartilage. Running outwards along the surface is the groove which conducts the Vidian nerve, and at its outer extremity the hiatus Fallopii, through which foramen the same nerve enters the substance of the bone. Near the upper margin, at the inner extremity, is the depression or fossa upon which rests the Gasserian ganglion of the fifth nerve, and at the outer extremity an elevation due to the prominence of the superior semicircular canal.

The outer wall of the fossa, formed by the squamous portion of the temporal bone, presents the markings of the convolutions of the brain and grooves formed by the passage of the middle meningeal artery.

*The posterior fossa* is formed by the occipital bone, by the mastoid portion of the temporal bone, and by the posterior surface of the petrous portion of the temporal bone. The extent of the fossa upon the occipital bone is bounded by the groove for the lateral sinus, the borders of which give attachment to the tentorium cerebelli: within the groove there is often a large canal for the transmission of a mastoid vein, and below the groove is the depth of the fossa which receives the hemisphere of the cerebellum. More anteriorly and nearer the central line of the skull is the large aperture of the foramen magnum, and in front of it a small orifice, the anterior condyloid foramen, through which the ninth nerve leaves the skull. Proceeding from the foramen magnum to the sphenoid bone is the basilar process of the occipital bone, grooved longitudinally for the medulla oblongata, and having a partial groove along the outer border for the inferior petrosal sinus. At the line of junction of the petrous portion of the temporal bone with the occipital is a large aperture, the foramen lacerum posterius, through which the lateral sinus opens into the internal jugular vein, and the three divisions of the eighth nerve leave the skull.

The posterior surface of the petrous portion exhibits along its superior margin the groove for the superior petrosal sinus, and along its inferior margin, internal to the foramen lacerum posterius, a half groove completed by the basilar process of the occipital bone for the inferior petrosal sinus. About the centre of the surface is the meatus auditorius internus, which is occupied by the seventh cranial nerve, and in its depth presents one larger orifice at the upper part, the aqueductus Fallopii, for the portio dura or facial division of the same nerve, and several smaller foramina at the lower part for the filaments of the portio mollis or auditory division of the seventh nerve; and some little distance external to the meatus is a small orifice overlapped by a fine sheath of bone, the aqueductus vestibuli.

## THE TEMPORAL FOSSA.

The temporal fossa is the space occupied almost entirely by the temporal muscle, and extends from the temporal ridge on the frontal and parietal bones downwards to the level of the zygomatic process, where it becomes continuous with the zygomatic fossa. It is bounded by the frontal, great wing of the sphenoid, parietal and temporal bones; and anteriorly by the malar bone.

## THE ZYGOMATIC FOSSA.

The zygomatic fossa is bounded in front by the superior maxillary bone, in which are seen the foramina for the posterior dental vessels and nerves; externally by the malar bone and the zygoma; internally by the external pterygoid plate, from which the external pterygoid muscle arises. It is continuous with the temporal fossa above, from which it is separated by the zygoma and a horizontal ridge upon the greater wing of the sphenoid; it is continuous internally with the spheno maxillary fossa, with which it communicates by means of the pterygo maxillary fissure; and it is connected to the orbit by the outer part of the orbital fissure.

## THE SPHENO MAXILLARY FOSSA.

The spheno maxillary fossa is a small space between the pterygoid process of the sphenoid and the posterior part of the superior maxillary bone. Its posterior boundary is the pterygoid process, and upon it three orifices open into the fossa, the foramen rotundum superiorly for the transmission of the superior maxillary nerve, the Vidian and pterygo palatine canals below for the passage of vessels and nerves of the same name, the mouth of the former being also the position of Meckle's ganglion. The internal boundary is the perpendicular plate of the palate bone, which, by dividing at its summit into two processes, produces between them a notch or foramen (spheno palatine) connecting this fossa with the nose. At the lowermost part of the space, its extreme apex, are the upper orifices of the posterior palatine canals. The fossa is open at its outer aspect, presenting a large triangular aperture, the pterygo maxillary fissure, through which the internal maxillary artery passes, and again it communicates with the orbit by a similar aperture, the orbital fissure.

## The Orbits. (*Plate* XIX.)

The orbits are two large spaces for the eyes, situated beneath the frontal bone, and occupying a large portion of the face. Each is pyramidal in form, is composed of four walls, and has its apex inwards, and the line of its axis passing obliquely backwards and inwards, whilst its base is open to the surface and surrounded by a very strong margin of compact bone. The *roof* is formed by the orbital plate of the frontal bone, and posteriorly by a part of the lesser wing of the sphenoid. It is concave in every direction, and at its external anterior portion is still more markedly so for the production of a fossa for the lachrymal gland. At the junction of the roof with the internal wall two foramina pass from the orbit into the skull, of which the anterior transmits the nasal nerve and vessels from the ophthalmic; and the posterior, an ethmoidal artery, also from the ophthalmic. The superior margin of the orbit is perforated near its inner third by the supra orbital foramen, through which the supra orbital artery and nerve pass to the forehead, and still more internally is a depression for the attachment of the cartilaginous pulley for the superior oblique muscle. The *floor* is formed by the orbital plate of the superior maxilla, by the malar bone uniting with it in front, and quite posteriorly by a very small portion of the palate bone, the orbital process. The inferior oblique muscle takes origin from the anterior and internal part, and along the centre runs from behind forwards the infra orbital canal, for the passage of the infra orbital nerve and vessels. The *internal wall* is formed by the nasal process of the superior maxilla, the lachrymal, the orbital plate of the ethmoid and a small portion of the body of the sphenoid, in order from before backwards. Between the lachrymal bone and the nasal process of the superior maxilla, by which bones it is formed, the lachrymal canal leaves the orbit to open into the inferior meatus of the nose. The anterior and posterior ethmoidal or orbital foramina, already described, are connected with this wall equally with the roof.

The *external wall* is formed by the malar bone in front and the orbital plate of the sphenoid behind, and is marked by small foramina, through which twigs of nerve pass to the cheek. Between this wall and the floor is a space of considerable size, the spheno maxillary or orbital fissure, connecting the orbital with the zygomatic, and with the spheno maxillary fossæ.

*The Apex.* In the depth of the orbit may be seen two spaces, one the optic foramen, internal and above, the other the sphenoidal fissure, or foramen lacerum anterius. The optic foramen is the interval between the two roots of the lesser wing of the sphenoid, is of somewhat circular form, and transmits the optic nerve and ophthalmic artery from the cavity of the cranium into the orbit. The sphenoidal fissure, large internally but tapering as it runs outwards and upwards, is the space between the lesser wing and the orbital plate of the sphenoid bone, and transmits the third, fourth, ophthalmic division of the fifth, and the sixth nerves and ophthalmic vein.

## The Nasal Fossæ. (*Plate* XIX.)

The nose is divided by a perpendicular septum into two cavities, each of which has a roof, a floor, an external and an internal wall, and an anterior and posterior orifice.

The *roof* slants considerably at its anterior part, where it is formed by the nasal bone and part of the nasal spine of the frontal. Behind this it becomes horizontal, consisting of the cribriform plate of the ethmoid, in which are the numerous foramina for filaments of the olfactory nerve, and still more posteriorly it again descends, being composed of the under surface of the body of the sphenoid, the sphenoidal process of the palate bone, and the ala of the vomer. The *floor* is slightly concave from side to side, and is formed by the palatine process of the superior maxilla and the horizontal plate of the palate bone. From the anterior part near the septum the anterior palatine or naso palatine canal leaves the nose to conduct vessels and nerves of the same name to the mouth.

The *internal wall* or septum of the nose is formed near the floor by an elevated crest, the junction of the superior maxillary and palate bones of opposite sides; and fitting into a groove on the crest is the vomer, which usually curves somewhat into the left side, rendering that cavity smaller than the right. Above the vomer is the perpendicular plate of the ethmoid, and at its anterior margin, between it and the nasal bones, is the spine of the frontal bone.

The *external wall* is formed by the following parts, which are in order from before backwards: the superior maxilla, with its nasal process; the nasal surface of the lachrymal; the cellular mass of the ethmoid; the perpendicular plate of the palate bone, and the internal pterygoid plate of the sphenoid. Attached partly to this wall, and extending inwards into the cavity of the nose, are the three turbinated or spongy bones, superior, middle, and inferior respectively, overlapping three spaces, the superior, middle and inferior sinus or meatus of the nose. Each meatus passes horizontally from before backwards, and receives the openings of neighbouring spaces. The superior meatus is overlapped by the superior turbinated bone, the smallest of the three placed far back in the cavity, and it receives the orifice of the posterior ethmoidal cells. The spheno palatine foramen and sphenoidal cells are also described as entering into this sinus, though neither of them are under cover of the turbinated bone. The middle meatus receives the orifices of the anterior ethmoidal cells, a large duct termed the infundibulum, common to the frontal sinus and to one or more anterior ethmoidal cells, and the orifice of the antrum. The inferior meatus receives one orifice only, that of the lachrymal duct, a canal extending from the orbit to the nose, and formed by the nasal process of the superior maxilla, the lachrymal bone, and the inferior turbinated.

The *posterior nares* or posterior orifices of the nose, are two large spaces opening into the pharynx, oval in form with the long diameter vertical, placed side by side and separated from each other by the posterior free margin of the vomer. The outer margin of each is formed by the internal pterygoid plate; the inner by the vomer; the lower by the free border of the horizontal plate of the palate bone, which projects internally as a fine process, the posterior nasal spine; and the upper by the lower surface of the body of the sphenoid, with the ala of the vomer and the sphenoidal process of the palate bone projecting upon it. This boundary is traversed from before backwards by the pterygo palatine canal.

The *anterior orifice* of the nose is not so perfectly divided by a septum, though the septum can be seen by looking into the cavity. The entire aperture is of irregular form, longer from above downwards than from side to side, and bounded laterally by the nasal and superior maxillary bones, which latter, at their junction at the lowest point of the orifice, project in the form of a small sharp process, namely, the anterior nasal spine.

## THE ORGAN OF HEARING. (*Plate* XX.)

The osseous portion of the organ of hearing is composed of three parts, the external auditory canal, the middle ear or tympanum, and the internal ear or labyrinth.

The external auditory canal is a little less than an inch in length, and extends from the external orifice into the substance of the petrous portion of the temporal bone, as far as the middle ear, the two cavities being separated by the membrana tympani, a fine membrane with which certain small bones in the tympanum are connected.

This canal is formed by the vaginal process in front and the rest by the petrous portion, but the orifice lies between the mastoid process and the glenoid cavity, and in the fœtus is composed of a separate ring of bone. The canal is longer on its floor and anterior wall than on its roof and posterior part, owing to the obliquity of the membrana tympani.

## THE MIDDLE EAR, OR TYMPANUM.

The middle ear, or tympanum, is a cavity within the substance of the petrous portion of the temporal bone, across which the chain of bones passes to connect the membrana tympani with the labyrinth. This cavity is six sided, possessing a roof, floor, an external and internal wall, and an anterior and posterior extremity. It extends in the same direction as the petrous portion of the temporal bone, inwards and forwards, being nearly half an inch in length, and about one quarter in breadth. By the obliquity of the membrana tympani, already described, the floor and anterior extremity are decreased in size for the enlargement of the corresponding parts of the external auditory canal. The roof is formed by the anterior surface of the petrous portion of the temporal bone, and corresponds to that part immediately in front of the elevation of the superior semicircular canal.

The floor presents nothing of note, but lies over the position of the jugular fossa.

The external wall is occupied chiefly by the oval space across which the membrana tympani is stretched, and behind this appears a small orifice through which the chorda tympani nerve, or branch of the facial, enters the tympanum. In front of the membrana is a small orifice, extending into a canal, through which the chorda tympani leaves the tympanum, and running parallel to this is the Glasserian fissure, which gives passage to the laxator tympani muscle and the tympanic vessels, and contains attached within it the processus gracilis of the malleus.

The internal wall faces the membrana tympani, and presents, first, along its upper margin an elongated ridge, due to the course of a canal, the aqueductus Fallopii, through which the portio dura of the seventh nerve runs; and below this a hole, the foramen ovale or fenestra ovalis of oval form, transversely placed and occupied by the base of the stapes which is attached to the margin by a ligament. If the stapes be removed the foramen ovale opens into the vestibule. Still lower and more anterior there is a prominence of considerable size, termed the promontory, which is hollow, corresponding to the cavity of the cochlea, and is marked on its surface by small grooves, in which lie twigs of the tympanic plexus of nerves. Behind the promontory, at its lowest part, a foramen, the fenestra rotunda, leads into the cavity of the cochlea, but when recent it is closed by a membrane.

The posterior extremity is marked by several irregular foramina leading into open spaces, the mastoid cells, among which the short crust of the incus is attached by a ligament; and below these, near the internal wall, a conical process, the pyramid, which is hollow within, and gives origin by its cavity to the stapedius muscle.

The anterior extremity gradually contracts, and from it pass forward two parallel canals, situated one above the other, and separated by a thin lamina of bone, the processus cochleariformis. Of the two canals, the superior transmits the tensor tympani muscle inwards to the tympanum, as well as a branch of nerve derived from the otic ganglion, and the inferior is continued onwards by a cartilaginous prolongation to form the Eustachian tube, and, opening into the pharynx, gives passage to air from that cavity into the tympanum, and thence into the mastoid cells.

## The Small Bones of the Ear (Ossicula).

Within the cavity of the tympanum are contained three small bones, which by their attachments connect the membrana tympani with the internal ear. The bones receive their names from things to which they bear resemblance—malleus, incus, and stapes.

The *malleus* (hammer) presents a large oval extremity, the head, and below this, a constricted portion, the neck, from which two processes extend, one from its size and direction is termed the handle or manubrium, and from its base projects a small conical elevation, the processus brevis, the other from its length and fineness is called the processus gracilis.

The head, situated near the roof of the tympanum, to which it is attached by the suspensory ligament of the malleus, articulates by its posterior surface with the body of the incus, the joint having a capsular ligament and synovial membrane.

The neck, or constricted part of the bone, receives the insertion of the laxator tympani muscle. The manubrium, the thickest of the processes, is somewhat curved, and is attached in the substance of the membrana tympani in its central line from above downwards.

The processus gracilis, a long and thin process, extends forwards and downwards into the Glasserian fissure, and is there attached.

The processus brevis projects upward and outward, and receives the insertion of the tensor tympani muscle.

The *incus* (anvil) consists of a body and two crura, one longer than the other. The body is flattened and quadrilateral, with a concave smooth articular facet for articulation with the head of the malleus. Of the crura, the shorter projects backwards to the mastoid cells, where it is attached by a ligament; the longer extends downwards parallel with but on a plane internal to the manubrium of the malleus, and articulates with the head of the stapes, a small cubic piece of bone or cartilage termed the os orbiculare, intervening. As age advances this structure ossifies to the incus and sometimes to the stapes also.

The *stapes* (stirrup) is described as possessing a head, neck, two crura, and a base. The head and neck, however, consist only of a small tubercle of bone, which articulates with the os orbiculare, and receives the insertion of the stapedius muscle. The base is a flattened oval lamina of bone, fitting into the fenestra ovalis on the inner wall of the cavity of the tympanum, and the two crura unite the base with the neck, the anterior crus being straighter, and therefore shorter, than the posterior. The position of the stapes is horizontal with the base inwards, the head outwards and at right angles to its articulation with the long crus of the incus.

## THE INTERNAL EAR, OR LABYRINTH.

The internal ear, or labyrinth, is composed of three separate portions, the vestibule most central, behind this the semicircular canals, and in front the cochlea.

The vestibule is an irregular space within the substance of the petrous portion of the temporal bone, situated with the cavity of the tympanum on its outer side, the meatus auditorius internus on its inner, the cochlea in front, and the semicircular canals behind. It is seemingly composed of two fossæ, of these the fossa hemi-elliptica, which is in the upper and posterior part, is of elongated form, whilst the fossa hemispherica, which is the smaller, is in the lower and anterior part, and is of somewhat spheroidal form, the two being separated by a horizontal ridge of bone extending from the inner wall of the vestibule, and termed the crista vestibuli. On the internal wall minute orifices (macula cribrosa) lead into the fossa hemispherica for the transmission of filaments of the auditory never, and behind the crest is a small orifice, the aqueductus vestibuli, for the passage of a vein. On the outer wall the vestibule communicates with the tympanum by means of the fenestra ovalis, but this foramen, when recent, is occupied by the base of the stapes and covered by the lining membrane of the cavities. In the posterior wall five orifices communicate with the semicircular canals, and are not closed in the recent state, and again in the anterior and lower part of the vestibule an orifice of some size enters into the scala vestibuli of the cochlea, likewise always open.

## THE SEMICIRCULAR CANALS.

The semicircular canals are three in number, placed two in a vertical position, one above and anterior to the other, producing the eminence upon the anterior surface of the petrous portion of the temporal bone, and one in a horizontal position external to the others. All open into the posterior and upper part of the vestibule by both their extremities, but the two vertical canals are united together by one extremity, so that instead of six there are but five orifices opening into the vestibule. Each canal is rather more than a semicircle, and at one extremity forms a dilatation, the ampulla. This dilatation occurs in the vertical canals at the extremities which are not united, and in the horizontal canal at that extremity which is the more anterior.

## THE COCHLEA.

The cochlea is of pyramidal form, with the base exactly corresponding to the meatus auditorius internus, and the apex extending forwards and outwards. It consists of a tube taking two turns and a half around a central axis termed the modiolus, and much resembles the shell of a snail lying upon its side. A thin lamina of bone, the lamina spiralis, coils in a similar manner round the modiolus, and taking attachment to it thus partially divides the tube into two parts, each of which is called a scala. The lamina does not extend entirely across the canal from the modiolus to the outer wall, but in the recent state a membrane is attached to the margin, and so completes the separation of the two scalæ. The lamina is also deficient in the apex of the cochlea, allowing the two canals to become continuous with each other; and to the point of junction is given the name of the cupola.

The two scalæ produced by the lamina spiralis communicate with each other at their extremities in the apex of the cochlea, but at their extremities in the base they open, the smaller into the cavity of the vestibule, hence termed the scala vestibuli; the other through the foramen rotundum into the cavity of the tympanum, and termed the scala tympani; but the foramen rotundum in the recent state is closed by a membrane stretched from its margin. In the scala tympani, near to the foramen rotundum, is found a small orifice, the aqueductus cochleæ. The *modiolus* is the axis around which the scalæ turn. It is composed of cancellated bony tissue, along which vessels and nerves pass to the substance of the lamina spiralis, and it generally possesses a central canal, in which is contained the trunk of the vessels and nerves of the cochlea. It is largest in size at the base, gradually decreasing, but near the apex again somewhat increases, and this enlargement, from its appearance, is termed the infundibulum.

The aqueductus Fallopii, or canal containing the portio dura of the seventh nerve, traverses the substance of the petrous portion of the temporal bone, commencing from the internal auditory meatus, being there the uppermost and largest of the orifices, and terminating at the stylo mastoid foramen. In its course it is soon joined by the hiatus Fallopii, a canal containing the large superficia petrosal or Vidian nerve, and then turns suddenly backwards along the upper part of the inner wall of the cavity of the tympanum above the foramen ovale, around and behind which it now as suddenly descends to its termination, the stylo mastoid foramen.

# OSSIFICATION.

With regard to the ossification of the bones, there is yet in many points a vast difference of opinion. This is in a great respect due to the difficulty which exists in obtaining specimens of the required periods of development, and of the gradually increasing ages of the fœtus, all of which, in the human species, come into the possession of the anatomists through accident alone. Under such circumstances research becomes almost impracticable, and a knowledge from such a source attainable only after a laborious and very extended investigation. The author has, therefore, determined upon presenting to the student the subject of ossification as generally entertained by more profound observers.

## THE VERTEBRÆ.

Each vertebræ is developed from three distinct points of ossification, one in the centre of the body, and one on each side of the arch, from which latter the articular and transverse processes are formed; and the spine, by the junction of the ossific matter of the two sides. About the age of puberty, or soon after, separate osseous points appear in the extremity of the spinous and transverse processes, and at a later period two others upon the body, one for each of its articular surfaces. The atlas and axis, since they differ from the ordinary form of vertebra, differ also in their development, the former having three points and only one epiphysis, which occurs in the spine, and the latter two extra points for the odontoid process.

## THE RIBS.

The ribs are developed chiefly from one point for the shaft, the head and tubercle remaining cartilaginous till some time after puberty, when they become ossified as epiphyses. It must be remembered that the eleventh and twelfth ribs possess no tubercle.

### The Sternum.

Each piece of the sternum is developed from a separate ossific point. Occasionally there are two or even four points for the first piece, which does not become united to the rest of the bone until old age, and frequently not at all: the remaining four pieces are joined together and often include the ensiform cartilage, as one bone, about forty years of age.

## THE BONES OF THE UPPER EXTREMITY.

### The Clavicle.

The clavicle is the first of all the bones to ossify, and is developed from one point near the centre of the shaft. The sternal extremity ossifies as an epiphysis, and unites with the shaft about twenty-five years of age.

### The Scapula.

The chief part of the scapula is developed from one point, commencing very early in fœtal life, and spreading out into the ala, spine, and head. A second point for the coracoid process commences shortly after birth. Other points, namely, two for the acromion process, one for the inferior angle, and one for the internal border, become developed about the age of puberty, and the entire bone is completely ossified at twenty-five years.

### The Humerus.

The shaft of the humerus is developed from a single point. The upper extremity is formed afterwards from three points, one for the head and one for each of the two tuberosities. At the same time, probably in the second year, the lower extremity of the bone commences ossification by a point in the capitellum, followed by a second for the internal condyle; and, some years afterwards, by a third for the trochlear surface; and a fourth, for the external condyle, making in all eight points. The two extremities do not, however, become united to the shaft till the eighteenth, or twentieth year.

## THE RADIUS.

The radius ossifies from three points, one for the shaft and one for each of the extremities; the upper of which becomes united to the shaft about the age of puberty, and the lower not until beyond the twentieth year.

## THE ULNA.

The ulna, like the radius, is developed from three points one for the shaft and one for each extremity. The extremities likewise become united to the shaft at about the same period as those of the radius.

## THE CARPUS.

Ossific matter is not deposited in any of the carpal bones until after birth. The largest of the series, the os magnum, is the first to commence and the smallest, the pisiform, is the last, the ossific matter in the latter bone being formed about the twelfth year.

## THE METACARPUS.

The metacarpal bones are developed from two points, one in the centre of the shaft and the second in the head or phalangeal extremity; union not taking place until the same time as the extremities of other long bones unite, about the twentieth year. The metacarpal bone of the thumb however, bears resemblance, as will be afterwards seen, to the phalanges, having the second ossific point not in the head but in the base or carpal extremity of the bone.

### THE PHALANGES.

The phalanges likewise ossify from two points, one for the shaft and small extremity, and the second for the base, in the same manner as the metacarpal bone of the thumb.

## THE PELVIC BONES.

### THE SACRUM.

The sacrum being an extension of the spinal column, bears close resemblance to the vertebra in its ossification. The five sacral vertebræ are formed each from three points, one for the body, and two for the laminæ, as well as one for each surface of the body, which is developed as an epiphysis, and the lateral parts of the sacrum which correspond to the transverse processes have an extra point for each of the four upper vertebræ, so that in all there are thirty three ossific points. The several segments commence to unite soon after puberty, but the entire bone is not complete until upwards of thirty years of age.

### THE COCCYX.

The coccyx is ossified from one point for each of its segments, and afterwards becomes united to the sacrum.

### THE INNOMINATE BONE.

The innominate bone is composed of three separate pieces, and has, therefore, three main points of ossification. At about puberty the ossific matter becomes deposited in the cartilage intervening between the three bones in the acetabulum, and afterwards in an epiphysis along the crest of the ilium. The anterior inferior spine next ossifies from a separate point, and a layer of bone becomes developed upon the tuberosity of the ischium, and at the symphysis pubis; eight points in all from which ossification commences. The bone is perfect between the ages of twenty-five and thirty.

## THE BONES OF THE LOWER EXTREMITY.

### THE FEMUR.

The femur is developed chiefly from the point for the shaft, the lower extremity and head being formed as epiphyses. In the fourth year the great trochanter commences to ossify, and at puberty a point appears in the lesser trochanter. Ossification is complete about the twentieth year.

### THE PATELLA.

The patella ossifies from one point.

### THE TIBIA.

The tibia is developed from three points, one for the shaft, and one for each extremity. The upper extremity unites with the shaft at about the twenty-fifth year, but the lower several years previously.

### THE FIBULA.

The fibula ossifies from three points, one for the shaft, and one for each extremity. It is generally complete some time before the tibia.

### THE TARSUS.

The bones of the tarsus are developed each from one point, but the os calcis has also a bony lamina upon its posterior extremity, generally united to the bone about puberty.

### The Metatarsus.

The metatarsal bones are formed chiefly from one ossific centre, which includes the shaft and tarsal extremity. A second point occurs in the head or phalangeal extremity of the bone, which is developed as an epiphysis. The metatarsal bone of the great toe differs from the rest, in that the base, instead of the head, is developed as the separate epiphysis, in which respect it resembles the phalangeal bones.

### The Phalanges.

The phalanges are developed from two points, one for the shaft and small extremity, and a second for the base, which is formed as an epiphysis in the same manner as the metatarsal bone of the great toe is developed.

## THE BONES OF THE HEAD.

### The Occipital Bone.

For some time after birth the occipital bone is composed of four pieces, the whole of the vertical portion in one piece, the basilar piece, and two lateral pieces. The vertical portion is developed from four points, one in each of the four fossæ, into which the cerebral surface is divided, the four points meeting in ossification at the internal protuberance or position of the torcular herophyli. The lateral pieces are developed each from one point, commencing in the condyle, and the basilar piece also from one; in all seven centres of ossification. The bone is completely united about the seventh year.

### The Parietal Bone.

The parietal bone is developed from one point only, situated at the parietal eminence. The two upper angles do not ossify for some months after birth, accounting for the anterior and posterior fontanelles.

## THE TEMPORAL BONE.

The temporal bone has an ossific centre for each of its three divisions, squamous, petrous and mastoid; also one for the zygomatic process, one for the tympanic bone, and one for the styloid process, which last occasionally does not unite to the bone, but articulates with a movable joint: in all six points. Frequently, however, the zygomatic and squamous portions are developed from the same point, making only five points.

At birth the tympanic bone is simply a ring around the meatus auditorius externus, but it afterwards becomes considerably enlarged, and deepens the cavity of the glenoid fossa, to the formation of which it contributes.

## THE FRONTAL BONE.

The frontal bones ossifies from two points, one at each of the frontal eminences.

## THE SPHENOID BONE.

The body of the sphenoid bone is developed from two points, one in front and one at the posterior part. Each of the lesser and each of the greater wings has a separate point; that for the lesser being situated at the junction of its two roots external to the optic foramen; that for the greater spreading also into the external plate of the pterygoid process. The internal pterygoid plate has a separate point of ossification, and so also has each of the sphenoidal turbinated bones. In all ten points.

### The Ethmoid Bone.

The ethmoid bone is developed from three points, one for each lateral cellular mass, and one which includes the perpendicular and cribriform plates and crista galli.

The lateral masses increase in size very considerably after birth, by the enlargements of their contained cells.

## BONES OF THE FACE.

### The Superior Maxillary Bone.

The superior maxillary bone ossifies rapidly, having a separate point for the palatine process, the malar portion, the facial portion, the nasal process, the incisor portion (that is, the part including the incisor teeth), and a variable number for the alveoli. Occasionally the incisor portion does not unite with the rest of the bone, but leaves a large open fissure upon one or both sides (Hare lip).

### The Palate Bone.

The palate bone, though of a remarkably irregular form, ossifies from one point only, situated at the root of the tuberosity, the junction of its several parts.

### The Malar Bone.

The malar bone is developed from one point only.

### The Lachrymal Bone.

The lachrymal bone has one centre of ossification.

### The Nasal Bone.

The nasal bone has one centre.

## The Inferior Turbinated Bone.

The inferior turbinated, or spongy, bone has one point.

## The Vomer.

The vomer is developed from one point.

## The Inferior Maxillary Bone.

The lower jaw is one of the first bones to ossify. It is developed chiefly from two points, one for each side, the two uniting at the symphysis. There is also a separate point for the condyle and for the coronoid process, and also one for the internal lamina of the bone.

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After the completion of ossification, bone substance consists of about one third of animal matter (gelatine), and the remaining two thirds earthy matter, chiefly phosphate of lime, with some carbonate of lime and a little phosphate of magnesia. To the animal matter is due the elasticity of the bone, and to the earthy matter the solidity ; and if beyond this proportion one preponderates over the other, disease is produced; either of rickets, distorted bones, on the one hand, if the animal matter preponderate, or of extreme brittleness and fragility on the other hand, if the earthy matter preponderate.

The development of the bones takes place according to the time and manner of its requirements; for it is seen from the foregoing, that the shafts of long bones are very considerably advanced in ossification at the time of birth And again, that certain bones, such, for instance, as those of the head, rapidly ossify after birth, and, on the contrary, that the epiphsysis of long bones do not become united to the shaft until from twenty to twenty-five years of age, when the stature has ceased to increase.

Then, with regard to the substance of bones, the ossifie matter is deposited either in extreme closeness, as occurs in what is termed compact osseous tissue, of which the greater portion of the shaft of a bone is composed, but only a thin layer upon the heads or large extremities; or, in large open reticulations, as occurs in what is termed the cancellated osseous tissue, of which the chief part of heads or large extremities of bones is composed, and only a small central portion of the shaft; the former variety being evidently for strength, the latter for volume without weight. In consequence of the different forms which bones present, they have been divided into separate classes:—

1. Long bones, such as those of the limbs, the metacarpus, metatarsus, and phalanges.

2. Short bones, such as the vertebræ, carpus.

3. Flat bones, such as those enclosing cavities; a good example being the bones of the head.

A fourth is described, including bones which scarcely bear resemblance to either of the foregoing classes; examples being the lower jaw, the sternum, and the ribs.

The flat bones of the head differ from other bones, in having two laminæ of compact tissue, termed the external and the internal table, separated from each other by layers of cancellated tissue, termed the diploe, in which are found large veins and nutrient vessels.

The temporal bone is peculiar in possessing a squamous portion resembling the flat bones of the skull; a mastoid portion, composed of large cells and cancellated structure, and a petrous portion, composed chiefly of the solid compact tissue, protecting the organ of hearing.

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